THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XVIII.—*On a Specimen of Native Iron from Liberia, Africa;* by Dr. A. A. Hayes.

[Read at a meeting of the American Academy, Boston, August, 1855.]

It is with pleasure that I submit to the inspection of the Academy, a specimen of Native Iron from Liberia, believed to have been taken from the tract of country bordering the St. John's River, recently acquired by the New Jersey Colony. This specimen was placed in my hands by Rev. Joseph Tracy, Secretary of the Massachusetts Colonization Society, for examination; and its physical characters at once arrested my attention as differing from those of any artificially produced iron. As I deem the discovery of native iron, existing unalloyed, a matter of much interest to naturalists and chemists, it is proper that the evidence on which the statement rests, should be submitted somewhat in detail. In the African Repository, vol. xxx, No. 8, August, 1854, at p. 240, is a letter from Rev. Aaron P. Davis, a resident missionary at Bassa Cove, from which the following extracts are taken: "I send you a piece of African ore just as dug from its native bed, or broken from among rocks. I have seen and conversed with a number of natives, who affirm that it is actually the pure ore, or just as taken from its native bed. I obtained a piece through Hon. Geo. L. Seymour, who had tried in vain to dissect it: and I being of that craft, he brought it to my shop for that purpose. When he brought it, it appeared like a craggy rock, of yellowish color on its surface, and with a very small exception

it could not be separated but by heat, and hard pounding with my largest sledge hammer, and a chisel prepared for the purpose. I also send you a tea spoon, which I made from some of the ore, which in its crude state is superior to the iron brought here for sale by English merchant vessels. I am told by the natives that it is plentiful, and about three days' walk from our present place of residence, (Bassa Cove,) it is gotten by digging and breaking rocks. It is also said to be in large lumps. In these parts the natives buy no iron, but dig it out of the ground, or break the rocks and get it, as the case may be."

The larger specimen before you, when received by me, bore on one side the impress of the chisel, the coarse fracturing of a tough metal, and marks of oxydation by fire. It was further identified by Wm. Coppinger, Esq., of Philadelphia, as the piece received with the letter of Mr. Davis. Mr. Coppinger gave the specimen to Rev. H. M. Blodgett, who sent it to Rev. Joseph Tracy, from whose hands I received it. Soon after I had expressed to Mr. Tracy my belief that the specimen was native iron, he placed before me a large amount of written evidence, showing that malleable iron, sufficient in quantity to meet the wants of the natives, is obtained by heating, and thereby fracturing the rocks of the country. The writers use the term *ore* incorrectly, as Mr. Davis does, apparently in the belief that iron ores increasing in richness become malleable. The metallurgical knowledge of the natives is so limited that they are unable to produce copper from the carbonate of copper, (Malachite,) which they carry five or six hundred miles, as a medium of traffic; while their weapons of iron which I have examined, show the characters of native iron after it has been heated and hammered.

Physical Characters.—On developing the internal structure of the mass of iron, by immersion for a few moments in strong nitric acid, and immediately after washing in a mixture of lime and water, it was apparent that the minute crystalline particles were arranged in a manner closely resembling those of the pure iron in meteoric masses, and entirely unlike the particles in artificial iron.*

* The character which is here noted has a higher value in a research of this kind, than would have been inferred from a cursory examination. In a description of the remarkable meteoric iron published in this Journal, (Nov. 1844,) I alluded to the fact, that these masses are not made up of iron alloyed with nickel and other metals, but consist of pure iron through which are mixed portions of an alloy of nickel and iron and iron and nickel, and other bodies as distinct *electro-negative matter* in relation to the pure iron. The Texas meteoric mass, and the small particles of the Weston meteorolite had the same mechanical constitution. Since the first publication of my results, these researches have been extended so as to include the metals of commerce and the well known alloys. The numerous analyses made on these forms of matter have not yet shown an exception to the condition, that, *the metal existing in the largest proportion is in part pure, while one, two, three or more alloys may exist,* distributed through it. When we take the results on a mass of crude iron in the state of pig-iron, and on portions of the less, and more malleable iron of the different steps of the manufacture, we not only pursue the constituents chemically, but

Where the mass had been heated and had received blows, there was an approach to the appearance presented by artificial iron; but the internal parts and nearly the whole of the mass showed no marks of percussive, or laminating action. By the more complete development of the structure, certain points appeared which were evidently extraneous matter. Under the microscope these points showed crystalline minerals, which when separated proved to be quartz and octahedral oxyd of iron. A mineral with a lime and soda base, was also found. The iron was most readily acted on by chemical agents, where it was in contact with these minerals. Exposure of a surface to the action of an acid, not only brought the mineral particles to view, but produced cavities at the points where they existed, showing degrees of porosity influenced by their number.

The specific gravity of the most compact portion was 6·708. Its color lighter gray than any sample of artificial ductile iron I have seen. Repeated bending back upon itself, did not separate one fragment, but generally flaws appear, and thin portions break when doubled close. The presence of the minerals imbedded is felt when we file or saw the metal, but when heated and hammered these fuse into slags and the metal spreads and draws off like the best irons, yet showing the cavities and flaws, where the simple minerals had existed.

Chemical Characters.—It dissolves with effervescence in diluted hydrochloric acid, and if the acid and water are perfectly pure, the evolved gas has no odor. 200 grains dissolved in hydrochloric acid, the hydrogen gas was passed through pure alcohol kept cool, and was then allowed to bubble through an ammoniacal solution of nitrate of silver. The alcohol had not acquired odor, nor was there any coloration or change in the silver solution. The solution of iron was turbid, but soon deposited suspended matter, which was light gray colored, some heavy white

the mechanical state of the iron is at the same time open to view. A mass of pig-iron thus becomes associated with meteoric iron in the mechanical arrangement of its parts, and generally consists of perfectly pure and malleable iron, disturbed in the arrangement of its crystalline particles, by the interposition among them of a compound of iron and carbon, and of graphitic carbon; besides sulphids, phosphids, and arsenids of the alkaline metals. In the ductile iron these bodies have been nearly all removed by heat and mechanical operations, and new features impressed upon the metal. By simply removing the interposed foreign matter by chemical means solely, crude iron is left malleable, and its particles then show their subcrystalline forms, but not as they exist in the pure iron of the more perfect meteoric masses. All manufactured iron presents them arranged in lines, and interlaced by the action of the hammer, or extended in bundles in the act of drawing: while the laminating mill breaks them down, shingling them over, and felting together their serrated edges, in striking analogy of effect, to the operations of textile manufacturing. The mechanical texture of a mass of iron cannot be shown fully by the simple step of immersion as above given, but this is sufficient to enable one to observe whether the crystals have arranged themselves as aggregates, or been broken up and disturbed by violence; and often will serve to show the kind of mechanical action employed.

sandy grains, and some dark, nearly black particles had fallen. After collecting and drying these substances, they were placed under the microscope, which showed the heavier bodies to be quartz, with some facets and fragments of octahedral crystals proved to be magnetic iron ore. The light body was silicic acid rendered gray by iron oxyd.

Chlorine was passed into the filtered iron solution, which after being heated and cooled, was precipitated in a partly closed flask by gaseous ammonia passed into it in excess. After being heated by a vapor bath, the precipitate was separated by filter and washed.

The filtrate and washings evaporated were reduced to a dry mass, which afforded a minute quantity of soda and lime; no other substance was present.

Separate parcels of the precipitate by ammonia were used for the detection of phosphorus, arsenic, and boron, alumina and other earths and oxyds: a little silicic acid only was found.

Fifty grains of the filings of the iron were wet with a few drops of perfectly caustic soda solution, mixed hastily with crystals of pure nitrate of soda and chlorate of potash, and heated in a nearly closed platina crucible rapidly to bright redness in twenty minutes: no deflagration occurred and the fused salts were colorless.

The crucible after cooling, digested in a closed vessel with recently boiled pure water, gave its soluble part to the water. After subsidence the clear fluid was added to a dilute saturated solution of lime in ammonia in one vessel, and to a dilute solution of baryta in another These vessels were closed and left twelve hours and then presented nearly transparent solutions, no precipitates had fallen, but both showed the presence of silicic acid. The absence of sulphur and carbon was thus proved, and other trials confirmed these results.

Analysis.—In the following analysis and in repetitions, different slabs of the metal were used so as to obtain an average percentage composition of the mass.

A solution in pure water, of about one hundred and fifty grains of pure sulphate of copper, was used as a medium, in which the iron dissolved replaced by electrolysis, the copper deposited on the negative electrode of platinum, connected with a feeble constant battery.

26·30 grs. of iron solved in the fluid and 29·78 grs. of copper were deposited on the platinum, while 0·32 gr. of matter was precipitated.

The equivalent of pure iron being 28, the deposits of copper should have weighed 29·71; an accordance as near, as these experiments allow, when more than one form of matter is present.

0·32 the precipitate consisted of angular portions of quartz, fragments of crystals of magnetic iron ore and a flock of silica:

the microscope showed no carbon, by this, the most certain and delicate mode of testing known to me.

The slab of iron had lost 26·60 grains. The partly ferruginous solution, decomposed by hydrosulphuric acid, evaporated and calcined, afforded traces of lime and soda; which in every case have been found to result from the solution of this iron. These bases had been united to the flock of silicic acid and they had increased the deposition of the copper, above the amount equivalent to the iron.

Reduced to per cent proportions, 100 parts of this slab consisted of

Pure iron, - - - - - -	98·87
Quartz, iron ore and silicate, -	1·13
	100·

Another slip from the centre of the mass more nearly an average, afforded in 100 parts,

Pure iron, - - - - - -	98·40
Quartz crystals, magnetic iron ore and silicate of soda and lime,	1·60
	100·

These little slabs which had formed the positive electrodes, had not disengaged a bubble of gas, which always occurs when the metals of alkaline bases are alloyed. They also exhibited in their substance, the cavities which had contained the mineral bodies found.

I was desirous of making some comparative experiments, on a specimen of iron having the characters of native iron, as distinguished from meteoric iron. My friend, Prof. B. Silliman, Jr., kindly supplied me with two slips from the specimen, well known as having been found at Canaan, Conn. He expressed to me at the time a doubt, respecting the certainty of this mass being native iron.

On subjecting a slip to analysis by electrolysis, it broke up into iron, iron and carbon and pure graphite. Reduced to per cent proportions,

Pure iron, - - - - - -	93·057
Carbon, - - - - - -	2·666
Iron from carbon, - - - - -	1·361
Graphite, - - - - - -	2·916
	·100

In the arrangement of the alloy of carbon and iron and the lamina of graphite, it differed in no respect from "Kishy" iron, which has been allowed to repose in a heated state and is unquestionably an artificial iron: a product of the blast furnace.

16, Boylston st., Boston, July, 1855.

Art XIX.—*On the Telescopic Appearances of Saturn with a 7½-inch Telescope*;* by the Rev. W. R. Dawes.

In the spring of last year (1854) I availed myself of an opportunity of increasing the optical means in my possession, by the purchase of a 7½-inch object-glass, having a focal length of nearly 9½ feet. It is the work of Mr. Alvan Clark, of Boston, U. S., who has long been known in that city as a most successful painter of portraits, but took to the manufacture of telescopes as an amateur. Being dissatisfied with reflectors, on which he commenced his operations, he attempted the manufacture of object-glasses; and succeeded so well, that in the autumn of 1851 he communicated to me the places of some new and very close double stars, which he had discovered with glasses whose apertures were 4¾ and 5¼ inches. In the following year he completed an object-glass of 7⅛ inches aperture for the observatory at Williams College, which was tried at the Harvard Observatory by the Messrs. Bond, and highly approved; immediately after which he commenced one of 7½ inches aperture, intended to be retained and mounted equatorially for his own use. At his requet I sent him some extremely difficult tests, selected from Mr. Otto Struve's *Pulkova Catalogue;* several of which have a central distance of little more than half a second, and some even less. Yet of all these I soon received from the ingenious maker (who has also proved himself an acute observer) perfectly correct diagrams; together with the places of one or two extremely difficult new double stars which he had discovered with this glass. As a specimen of these, I may mention 95 *Ceti*, which is at present favorably situated for observation. Though unwilling to part with this glass, Mr. Clark consented to let me have it to try against my Munich telescope; and in March, 1854, it arrived, with its tube, finder, and eye-pieces.

Though the crown-glass has a considerable number of small bubbles, the performance of the telescope is not sensibly affected by that circumstance. In other respects the materials are good; and the figure is so excellent, and so uniform throughout the whole of the area, that its power is quite equal to anything which can be expected of the aperture; and consequently, both in its illuminating and separating power, it is decidedly superior to my old favorite of 6⅜ inches aperture. As a specimen of its light, I may mention the companion of *ν Ursæ Majoris* as having been pretty steadily seen with it; and also that I have never seen *Saturn* under tolerable circumstances during the present apparition without detecting *Enceladus*, even when at or very near his con-

* Extracted from the Monthly Notices of the Royal Astronomical Society for Jan. 7, 1855.

junctions with the planet. When exterior to a tangent to the extremity of the ring, this satellite has frequently been perceived as soon as my eye was applied to the telescope. Last spring it was seen several times in strong twilight; for instance, on March 16th, 17th, and 20th, at about 7^h G. M. T. In separating power, the glass is competent to divide a sixth-magnitude star composed of two equal stars, whose central distance is $0''.6$.

I have thought it proper to premise thus much respecting the performance of the telescope, that a correct idea may be formed as to the degree of dependence to be placed upon the views it has afforded me of *Saturn*; the special subject of my present communication, to which I will now proceed.

1. *The outer Ring* A.—The interior edge of this ring is decidedly its brightest part: its light rapidly fades away towards the middle, where there is a very dark, narrow, well-defined line concentric with the ring, and about one-fifth of its breadth by careful estimation. This line has been always seen when the air was in a tolerably good state, and much more readily than last year. On the 26th of November, 1854, it was traced more than half way round towards the ball, and was equally well seen at both ansæ. I have recorded on 10th January, 1855, "I am surprised at the positiveness of the dark line near the middle of this ring. It was well seen with every power from 355 to 1000." This is now the fourth apparition of *Saturn* in which I have noticed this dark line, and it does not appear to me to have varied in its position on the ring, or in its breadth and depth of shade.

2. *The interior bright Ring*, B.—The concentric shaded bands on this ring have been on two or three of the most favorable occasions very well brought out. On this appearance I find the following notes in my journal:—

"1854, Nov. 26. The ring B is decidedly in *stripes*, and they are not *regularly* darker from the exterior one inwards. About one-fifth of the breadth of the ring, from its exterior edge, is very bright; then a narrow stripe is lightly shaded; immediately within that is a stripe decidedly lighter, though not so bright as the exterior fifth; next to that is a considerably darker stripe, and then a *much* darker one extending nearly to the interior edge, where there is a *very* narrow *bright* line, far less decided than it was in 1851 and 1852."

"Dec. 7. By brief views the step-like character of the shading on ring B is visible; and I think the *outer* shaded band is *darker than the next interior one*, as I noticed one night before."

"1855, Jan. 10. The bands of shading towards the interior edge of this ring are occasionally well brought out; and I think the *second* from the outside is not quite so dark as the first,—at least in some parts of it, for I doubt if it be quite uniform. The narrow bright line at the interior edge is visible, but is not, I think, so bright as it was in the two previous apparitions."

3. *The obscure semi-transparent Ring* C, has been very well seen on several occasions; and I have noticed nothing remarkable about it except the occasional variations of its tint in different parts. Respecting this I have recorded as follows:—

"1854, Sept. 26. The dark ring is plainly seen, and appears to-night of the same tint at both ansæ. Its semi-transparency is very obvious across the ball, the edges of which can at times be distinctly traced down to the inner edge of ring B."

"Dec. 26. The dark ring is remarkably clear: the following end is *ruddier* than the preceding."

"1855, Jan. 10. The ring C is wonderfully well seen in general: rather ruddy on the preceding side, slate-colored on the following side. The ball is seen plainly, though faintly, through it."

4. *The Ball.*—Of its appearances I have the following notes:

"1854, Sept. 26. The belts on the ball are not very distinct. The southern boundary of the broad dark belt, which is immediately south of the equator, is *not uniform*, or parallel to its northern edge. Tho belt therefore, varies in breadth in different parts, and is at present ($13^h\ 45^m$ G. M. T.) broadest near the eastern edge of the ball. There is a very narrow light line seen interruptedly crossing the belt from east to west, a little south of its middle. The rest of the southern hemisphere is nearly uniform in color, except that round the south pole is a belt of rather darker tint, and at about 40° of south latitude there is a very narrow belt less dark than the polar one."

"Dec. 7. The annexed sketch" (in the journal) "shows the form of the shadow of the ball on the ring B. It does not extend to the ring A at all; but I think a very small portion ($0''.2\pm$) of the southern edge of the ball is projected upon A."

"Dec. 16, $12^h\ 30^m \pm$G. M. T. The south pole, or rather the most southerly part of the ball, is very dark,—much darker than the ring A, and I think rather darker than the broad belt near the equator. This renders the contrast with the small visible portions of its shadow less evident. I feel pretty sure that the southern edge of the ball encroaches a trifle on the ring A. There are no distinct and well defined belts on the ball now."

"1855, Jan. 10, $9^h \pm$ G. M. T. The whole of the southern hemisphere of the ball is ruddy, and the parts near the equator and at the southern edge are the darkest. Examined very carefully, and with all the various powers" (extending from 355 to 1000), "the position of the southern edge with respect to the edges of the rings at that part. The edge of the planet is so dark that it gives the impression sometimes of having a dark line there marking its contour. This darkness of the shading, at the very edge of the ball, renders it difficult to distinguish it from the division between the rings. But after long and careful examination, I am satisfied that *the ball extends over the division, and en-*

croaches 0″·2 *or* 0″·3 *on the ring* A. By carrying my eye across from the black division on one side to the other, I can see that, if continued in an uninterrupted line, it would *cut off a thin slice from the edge of the ball.* With very high powers (705 to 1000) the difference of color of the southern edge of the ball, and the ring A at that point is more marked than with the lower powers; and long scrutiny with them confirms my impression that the ball encroaches slightly on A."

"$10^h\ 36^m \pm$G. M. T. Applied an excellent Huygenian eye-piece, giving power 860. It is admirable. The difference of color of the southern edge of the ball and ring A is obvious; and there is no doubt at all of the slight encroachment of the ball on its interior edge. Finding the light of the planet produce a very unfavorable effect upon my eye while endeavoring to estimate the degree of encroachment of the ball on A, it occurred to me to apply my solar eye-piece for the purpose of excluding the rest of the ball and rings, and leaving visible only the southern portion of the ball and the adjacent portion of the rings A and B. Power 506 (the highest, a double-convex lens). The effect is admirable. My eye having rested upon it for some time, the outline of the southern edge of the ball was far more distinctly seen than before, and leaves no doubt of its encroaching on the interior edge of A, to about 0″·3 by careful estimation. At times a little mottling can be discerned very near the southern limb of the ball. Its color is very different from that of ring A; and it completely interrupts the black division which comes sharply up to the ball on both sides of it."

5. *The Shadow of the Ball on Ring* B. On this appearance I have noted as follows:—

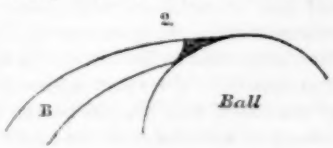
"1854, Sept. 26. The shadow of the ball on ring B is nearly a straight line."

1.

On Sept. 29 the projecting portion of the shadow, which has been noticed the last two or three years, was seen for the first time this season on the eastern side of the ball; cutting off the acute point of the ring B intercepted between the edge of the ball and the black division, as at *a* in the sketch, in which the appearance is much exaggerated.

At the same date I have remarked,—"I doubt if the shadow of the ball on ring B is really a straight line, though nearly so. It seems to be a little curved towards the southern end of it, close to the division." In the place indicated the edge is *convex* towards the ball.

2.



"Nov. 26. Only a *very* narrow line of shadow from the ball falls on the west side, but there is a curious angular projection in the shadow on both the west and east sides of the apex of the ball."

"Dec. 7. The annexed sketch shows the form of the shadow

3.

of the ball upon ring B." (Exaggerated in the sketch as respects the *size* of the shadow.)

6. *The Satellites.*—I have usually estimated *Tethys* to be brighter than *Dione*, even when it has been nearer to the planet. This was remarkably the case on the 10th of this month, at $7^h \pm$G. M. T., when both the satellites were near their greatest western elongation. At $11^h\ 19^m$ G. M. T., *Dione*, *Tethys*, and *Enceladus*, formed an equilateral triangle south-preceding the western end of the ring, thus,—

4.

In No. 929 of the *Astron. Nachrichten*, is a most interesting account by Professor Secchi of the appearance of *Saturn* in the Munich equatorial refractor, recently erected at the Observatory at Rome. The dimensions of the telescope are the same as those of the Dorpat refractor, the aperture of the object-glass being 9 Paris inches. The Professor characterizes the night of Nov. 19 as one of extraordinary excellence, and doing full justice to the telescope. He describes the dark line on ring A as being just like a *pencil line* drawn upon it, which perfectly agrees with the views I have had of it since 1851; and with my description as "narrow, very dark, but not black." And when the dusky hue of the ring A is considered, it seems probable that this line would appear almost black if contrasted with a much brighter ground, such, for instance, as the exterior edge of the ring B. It deserves to be remarked that a dark line, precisely similar to this in appearance and situation, was seen on the *northern* surface of this ring, in the year 1838, by Professor Encke; and by Mr. Lassell and myself in 1842 (when we were not aware of Encke's observation). It may not be a *division* in the ring, as it was then supposed to be; but, if it is not, it is certainly extraordinary that precisely the same appearance should exist *on both surfaces of the ring*, and should be, as it would seem, a permanent phenomenon in respect of its situation on the ring, and the darkness of its shade.

Professor Secchi has also described the step-like concentric bands of shading on ring B, exactly as they were described by myself on October 26, 1851: and as I have occasionally seen them almost precisely in the same way to the present time, it may fairly be concluded that they form a permanent feature of this ring. The Professor does not notice the *comparatively bright line* at the interior edge of B, which seems to me to render that edge pretty definite, though it is certainly less bright now than it was two or three years ago.

In one important point the impression received by Professor Secchi differs decidedly from my own, as stated in the present paper: viz., the place to which the southern edge of the ball is seen to extend on the rings. He states that the opening of the ring is such, that *the upper edge of the ball exactly touches the interior edge of the black division between* A *and* B, which was visible throughout the whole of its elliptic perimeter. It is singular that, on the 26th of September I arrived at precisely the same conclusion; but the state of the air was not such as to permit the advantageous use of high powers; and my subsequent observations, under much better circumstances, and especially on the 10th of this month, convinced me that my first impression was erroneous, or that a change to a considerable, and in fact *unaccountable*, amount had taken place.

The *first* satellite of *Saturn* (now usually called *Mimas*) is stated by Professor Secchi to have been seen on November 19th, near its great western elongation; having been found by putting the planet nearly out of the field, and afterwards seen steadily with the planet in full view. It is surprising that he does not mention *Enceladus*, which must have been close to *Mimas* at that time, if the latter occupied the place indicated. As my telescope has not shown me *Mimas*, I cannot say where that satellite might have been; but my own observations prove that *Enceladus* occupied precisely the situation which the Professor has ascribed to *Mimas;* and I cannot but think it probable that further observations may have convinced him that it was not the *first*, but the *second*, satellite which he saw.

The *bright zone on the ball*, which commences almost precisely at the equator, and extends northwards as far as the ring permits it to be seen, forms one of the most conspicuous features of the planet. It has been repeatedly referred to by Professor Secchi, as *caused by the reflection of the sun's light from the surface of the ring*. Two considerations seem to me to be quite conclusive against its arising at all from that cause. One is, that this bright zone occupied precisely the same situation, and was very conspicuous, *when the plane of the ring passed through the sun*. (See "Remarks on the Planet Saturn," by the Astronomer Royal, in the *Greenwich Observations* for 1844, p. 44.)

The other is, that the reflection of the sun's light from the *southern* surface of the ring, which now receives it, must necessarily fall upon the *southern* hemisphere of the ball, which has been remarkably dark ever since the southern surface of the ring has been illuminated; while the bright zone lies wholly in the *northern* hemisphere. The remarkable obscurity of the southern hemisphere at the present time seems to indicate that the effect of the reflection from the surface of the ring is quite inappreciable as seen from the earth.

Wateringbury, Jan. 11, 1855.

Postscript.—"Jan. 14. The night proving fine, I again carefully examined *Saturn*, and made the following entry in my journal:—

"'$12^h\ 45^m$ G. M. T. *Saturn* is very fine at times, though about $3\frac{1}{4}^h$ past the meridian. It bears 705 very well; and with this power I have no doubt of the southern edge of the ball extending over the division between A and B, and encroaching a trifle on the interior edge of A. With low powers (355 or less) there is sometimes an appearance of the division extending across; but I am persuaded that this arises from the combined effect of the division coming up on each side so near the apex, and the *very* deep tint of the apex itself, which I think is *darker* than the darkest part of the broad belt close to the equator of the planet. It is certainly much darker than the ring A.'"

Art. XX.—*On a new and advantageous mode of preparing Aluminium;* by Prof. H. Rose.

[Translated and read before the National Institute, Washington, D. C., Oct. 5, 1855, by J. Tyssowski, U. J. Dr.*

Since the discovery of Aluminium by Wöhler, Déville has recently taught us a method of obtaining it in larger connected masses, in which this metal shows qualities, which had not been observed in the metal as obtained in the form of a powder by the process of Wöhler. While in the latter form it burns with great brightness to a white clay, it may be, if fused into larger balls, heated to redness, without perceptibly oxydizing. These differences may be attributed to finer division and greater density, although according to Déville, Wöhler's metal contains some platinum which accounts for its less fusibility.

After the publication of Déville's investigations I tried also to obtain aluminium from chlorid of aluminium and sodium, by means of an additional dose of sodium. I did not follow entirely the method of Déville, but stratified the salt with the

* Poggendorff's Annalen, vol. xcvi, page 152.

sodium and then applied heat. I however obtained no satisfactory results. Rammelsberg also followed closely the method of Déville but obtained no good results; moreover he was seldom able to prevent the bursting of the glass-tubes with which he experimented in consequence of the action of the vapors of sodium upon the chlorid of aluminium. It appeared to me that considerable time, labor, expense and long experience would be necessary in order to obtain even small quantities of this remarkable metal.

The application of chlorid of aluminium and its compounds with the alkaline chlorids, is particularly objectionable for the reason that they are volatile, attract moisture very readily, and therefore the access of air must be prevented when treating them with sodium.

I therefore early thought of substituting for the chlorid of aluminium the fluorid of aluminium, or rather the compounds of the latter with alkaline fluorids and which are known to us from the investigations of Berzelius. Berzelius pointed out the strong affinity of fluorid of aluminium for fluorid of potassium and fluorid of sodium, and that the cryolite occurring in nature is a pure combination of the fluorid of aluminium with the fluorid of sodium.

This compound, in consequence of its constituents, is as well adapted to the preparation of aluminium by means of sodium, as the chlorid of aluminium and its compound with chlorid of sodium. And in addition to this, the cryolite not being volatile, easily reducible to the finest powder, free from water, and not attracting moisture from the atmosphere, it presents peculiar advantages in comparison with the fore-mentioned compounds.

I succeeded in fact in obtaining aluminium by heating powdered cryolite with sodium to redness in a small iron crucible much more easily than by a similar treatment of chlorid of aluminium and its compound with chlorid of sodium. The scarcity of the mineral however prevented me from continuing my experiments.

A short time since, I returned to them, on having obtained through Mr. Krantz in Bonn, a considerable quantity of the purest crystals and at a trifling expense (1 kilogram for 2 Prussian dollars). But my zeal was exalted by the unexpected news reaching me that cryolite may be obtained here in Berlin and at incredibly low prices.

Mr. Krantz had communicated to me his having heard that cryolite exists in masses in commerce, yet he could not learn where. A short time since Mr. Rüdel the Superintendent of the chemical manufactory of Mr. Kunheim near the Halle gate, presented to me a specimen of a white coarse powder, large quantities of which it is said have been sent from Greenland, through Copenhagen to Stettin under the name of mineral soda

at three Prussian dollars per cwt. Samples of 40 lbs. had been handed to the soap-manufacturers of this place: and in fact by treating them with burnt lime, a soda-ley was prepared from it, which probably from its very admixture with alumina proved very superior for the manufacture of certain soaps.

I recognised in this powder the mineral *Cryolite* of the same purity as the crystals obtained through Mr. Krantz. It dissolved perfectly (in a platinum vessel) and without leaving any insoluble matter in hydrochloric acid; the solution evaporated with sulphuric acid to dryness, showed a deposit, which heated to the expulsion of the free sulphuric acid, proved perfectly soluble in water with the aid of some hydrochloric acid. In the solution, a considerable precipitate of alumina was obtained by ammonia. A filtered solution thereof gave after evaporation and heating a deposit of sulphate of soda, which contained no potassium. Besides this, the powder showed the known reactions of fluorine in a very high degree.

This powder is therefore cryolite of great purity. Still the coarse powder which I obtained at first, was not the original form in which it comes in commerce. The cryolite arrives here in Berlin in large masses. For the purpose of preparing aluminium it must be reduced however to a very fine powder.

In my experiments for the preparation of the metal which I made conjointly with Mr. Weber and with important aid from him, I have used, thus far, for the most part, small iron crucibles $1\frac{3}{4}$ inches high, and $1\frac{3}{8}$ inches diameter, which I had cast in a foundery of this place. In these I stratified the fine cryolite powder with thin layers of sodium, stamped the whole pretty strongly, and covered it with a good cover of chlorid of potassium, and the crucible with a well fitting porcelain cover. Of all the fluxes, I found the chlorid of potassium the most advantageous; it has the least specific gravity, which in view of the very small density of the aluminium is of great consequence. Besides it fuses with the fluorid of sodium to a mass more fusible than the latter alone. I usually employed equal proportions of chlorid of potassium and of cryolite, and for five parts of the latter I took two parts of sodium. Ten grams of cryolite powder answered the best for the crucible.

The whole was then exposed to a powerful red heat, by means of a blowing apparatus, in which atmospheric air and illuminating gas is forced through pipes constructed after the principle of Daniell's pipe in the explosive gas-blowpipe apparatus. It appeared to be the best to continue the red heat during half an hour and no longer, keeping all the time the crucible carefully closed. Meanwhile the whole is well fused. After cooling, the contents of the crucible are best cleared by means of a chisel, which operation may be facilitated by gentle blows with a hammer on the

outside of the crucible. The crucible may be used repeatedly for new operations; though finally it will fall to pieces, in consequence of the blows applied.

The fused mass is treated with water. Usually no gases or only inconsiderable and hardly perceptible quantities of gas are evolved. The small amount of hydrogen given out has the same unpleasant odor as the gas forming during the solution of iron in hydrochloric acid. The carbon comes from the minute portion of naphtha which adheres to the sodium even after drying.

In consequence of the difficult solubility of the fluorid of sodium the fused mass softens but slowly. The addition of chlorid of potassium somewhat increases the solubility. After twelve hours the lumps are softened so much that after pouring away the liquid they may be flattened with a pestle in a porcelain mortar. Larger globules of aluminium are then found, weighing from 1·3 to 0·4 grams, which are separated. I have recently found them of a weight of 0·5 grams. The smaller globules cannot be separated by lixiviation from the alumina simultaneously formed and the cryolite underlying the latter, these being heavier than the aluminium. The whole is treated cold with dilute muriatic acid. This, although it does not separate the calcined alumina, yet gives the aluminium globules their metallic lustre. They are dried, and then the alumina particles and the non-decomposed cryolite powder is separated by rubbing upon silk muslin, the little metallic globules remaining upon the tissue.

The pouring of water over the fused mass is done in platinum or silver cups. Porcelain vessels ought to be avoided, their glazing being attacked strongly by the solution of the fluorid of sodium. The solutions clarified by being left standing in a large silver cup may be evaporated in platinum cups, in order to obtain the fluorid of sodium, which however is mixed with a considerable portion of chlorid of potassium.

The small globules of aluminium can be fused together in a small covered porcelain crucible under a cover of chlorid of potassium by means of a blowpipe. Attempts to unite them without the use of the crucible never succeed. The small globules can not be fused like small globules of silver, because the aluminium, although apparently it does not oxydize while heated with access of air, still it is during that process covered with an almost imperceptible pellicle of oxyd, which prevents the fusion.

The fusion under chlorid of potassium is always attended with a loss of aluminium. A globule of aluminium of 3·85 gr. weight lost by fusion under chlorid of potassium 0·05 gr. The chlorid of potassium after being dissolved in water, did not show any alumina, a small quantity of which however separated undissolved. Another part of aluminium unquestionably decomposed the chlorid of potassium; chlorid of aluminium and of potassium

must have volatilized by the fusion. Other metals comport themselves similarly, as copper and even silver.

I followed therefore the direction of Déville, and fused the globules of aluminium in a covered porcelain crucible under a cover of chlorid of aluminium and sodium. The salt was first fused and then the globules were introduced into the molten salt. In this way the loss of metal is none or very minute, at the most only a few milligrams.

If the aluminium is melted under a cover of chlorid of potassium, its surface is not thoroughly even, but shows minute excavations, which is not the case if it is melted under chlorid of aluminium and sodium.

The quantities of chlorid of aluminium and sodium to be employed for this purpose, are most easily prepared by bringing the mixture of alumina and charcoal in a glass tube of as large a diameter as possible, and by introducing in it another glass tube open at both ends of a smaller diameter filled with pulverized table-salt. By heating the space containing the mixture of alumina and charcoal very strongly, and that which contains the chlorid of sodium less, while passing the chlorine gas through the tube, the vapors of the chlorid of aluminium will be absorbed so eagerly by the chlorid of sodium, that no chlorid of aluminium or only a trace of it deposits on the other parts of the apparatus. If the smaller glass tube with the chlorid of sodium has been weighed beforehand, the quantity of the chlorid of aluminium it has absorbed can be easily determined. The latter however is not combined equally with the chlorid of sodium; that part which was next to the mixture of clay and charcoal, contains the most of it.

I have varied the process for the reduction of aluminium in many ways, but have returned to that described. Often the sodium was placed alone on the bottom of the crucible, over it the cryolite powder, and then the chlorid of potassium. In this case, copious vapors of sodium escaped, burning with a strong yellow flame, which did not take place if the sodium was cut in thin slices and stratified with the cryolite powder when the process goes forward very quietly. From the start, the incandescent crucible suddenly glows up vehemently while the decomposition of the compounds takes place. At this point the heat must not be reduced, but kept on, not however beyond half an hour. Through a longer glowing heat, a great loss would be experienced in consequence of the action of the chlorid of potassium upon the aluminium. Neither will the globules of aluminium become larger by a longer glowing heat, which was tried, up to two hours; this effect was produced only through the most intense heat possible. If, however, after the highest incandescence of the crucible, that is after five or ten minutes, the heating ceases, the

gain in aluminium is remarkably small, the metal then not having yet formed in globules, remaining in the form of a powder and burning up during the cooling of the crucible.

No greater gain is obtained if the cryolite powder be first mixed with a part of the pulverized chlorid of potassium and then stratified with the sliced sodium.

I also tried covering the cryolite stratified with sodium, with a layer of chlorid of aluminium and sodium, and heated the whole as usual. But I found no gain in this way.

I often employed, in place of chlorid of potassium, chlorid of sodium (common table-salt heated) without observing any considerable difference in the result. Only the heat has to be raised higher than when using chlorid of potassium.

The operation may also be performed in hard, fusible unglazed stone-ware crucibles of the same size as the cast iron crucibles aforesaid. At a very high temperature they only resist with more difficulty the action of the fluorid of sodium and melt in one or more places. The iron crucibles melt also, if when filled with the mixture for the preparation of aluminium they are exposed to a very intense charcoal fire.

The amount of aluminium obtained has, up to this time, been very variable, even with the same process and the same proportions of materials. The quantity of metal contained in the cryolite treated has never been reached. The latter contains 13 per cent of aluminium. By employing 10 grms. of cryolite a quantity, which was the standard in all experiments with the small crucibles, the most favorable product was 0·8 grm. of aluminium. If however, only 0·6 or even 0·4 grm. were obtained out of the 1·3 grm. which, according to calculation were contained in the cryolite treated, the result would still be called satisfactory. Often only 0·3 grm. and less were obtained.

These so different results depend on various circumstances, principally however, upon the degree of heating. The greater the heat the more the small globules unite into larger ones, and the less aluminium remains in the state of powder, which could during the subsequent cooling oxydize into alumina. I succeeded sometimes in uniting by fusing in a stone-ware crucible and with a very great heat, almost the whole quantity of the aluminium obtained into one single globule of 0·5 grm. weight.

The heat, which I am enabled to give by means of the blowpipe apparatus, is not equal at all times of the day, depending as it does upon the varying pressure to which the illuminating gas is subject in the gas metres of the city. But that a great loss of aluminium is caused through a very slow cooling under access of air which favors the oxydation of the small particles of the reduced metals, is proved by the following experiment.

In a large iron crucible 35 grams of cryolite powder were stratified with 14 grams of sliced sodium, and the whole covered with a thick stratum of chlorid of potassium. The crucible covered with a porcelain cap, was placed in a larger earthen-ware crucible, also covered, and exposed during an hour to a good charcoal fire in a well drawing wind furnace, and cooled as slowly as possible. The product in aluminium was in this case remarkaly small, only 0·135 gram. in globules being separable from the molten mass.

The varying result originates also in this, that through the varying stratification of the sodium with the cryolite powder, a large amount of the latter often escapes decomposition. The more sodium employed, the less is this the case; but because of the great difference in the price, I never took more than 4 grm. of sodium for 10 grms. of cryolite.

To avoid the loss resulting from the oxydation of the pulverulent aluminium during cooling, I tried some other methods of operation. 20 grms. of cryolite were strongly heated in a gun barrel exposed to a current of hydrogen, and then the vapors of 8 grms. of sodium passed over it. This was accomplished simply by introducing the sodium placed on a sheet-iron pan in that part of the gun-barrel which stood out of the furnace, and pushing the same in the fire only at the moment when the cryolite powder reached its highest point of incandescence. The operation went on admirably. I permitted the whole to cool in the hydrogen current. After lixiviation in water, in which the fluorid of sodium dissolved with great difficulty, I obtained a great quantity of a black powder, which for the most part consisted of iron, and which in its solution in hydrochloric acid showed but little alumina.

The smallness of the products which I obtained in most instances, must not deter from further investigations. They are the results of the first experiments in which I have been engaged and for a short time. Now when the cryolite may be obtained at so low a price, and as sodium (for the increased facilities of reducing which we are so much indebted to Déville) will also in future be much cheaper, any one may undertake to produce aluminium, and certainly in no distant time methods will be found that will afford satisfactory results.

Anyhow, I am of the opinion that the cryolite among all the compounds of aluminium will prove the most eligible for the production of aluminium. It possesses so many advantages over the chlorid of aluminium and the chlorid of aluminium and sodium, that it would be employed with the greatest benefit even if its price were considerably higher.

Aluminium has yet hardly been obtained directly from alumina. Potassium and sodium appear to effect the reduction of the me-

tallic oxyds only when the nascent potassium or sodium is at hand to combine with a part of the oxyd not yet reduced. Pure potash and soda, the properties of which are almost unknown to us, do not appear to form at that moment. And as alumina can very readily combine with alkalies to form an aluminate, it should be inferred, that the reduction of alumina through the alkaline metals might succeed in the end.

But even if it should become possible to obtain aluminium directly from alumina, still cryolite may for a long time be employed for the purpose, unless its price should rise immoderately. Nature furnishes this substance in a state of rare purity, the aluminium is combined in it only with fluorine and sodium—two substances which cannot act injuriously during the production of the metal. Clay or aluminous earth is however seldom found in a pure state, and always of great density. To reduce aluminous earth in large quantities from its compounds and to purify it from substances which could act injuriously during the production of aluminium—would be attended with great difficulties.

The globules of aluminium obtained by me are for the most part so extensible, that they may be flattened very considerably and rolled into the thinnest sheets without their showing fissures on the sides. They have at the same time a strong metallic lustre. On the contrary some few masses, found on the bottom of the crucible and sometimes adhering to it and which had no globular form, showed fissures when rolled, and differed somewhat in color as well as in lustre. They evidently were not as pure as the great majority of the globules, and probably contain some iron.

A larger globule of aluminium of 3·8 grm. weight having been sawn in two, it could be plainly seen that the metal was brittle for about half a line from the outside; but inside it was soft and pliable. Sometimes excavations are found in the interior of the globules.

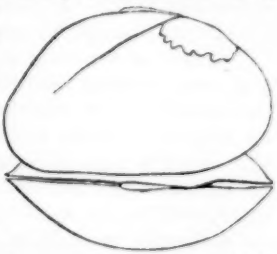
According to the observations of Déville I happened also to obtain the aluminium in crystalline form. One of the greater globules became in cooling radiated with crystals on its under surface. Déville believes he has obtained regular octahedral crystals, but does not however assert this positively. According to the investigations of my brother, the crystalline structure does not appear to belong to the regular system.

Trying to melt a larger globule accidentally contaminated after being rolled without flux, before the heat rose so as to melt the whole, small globules went floating on the surface. The impure aluminium is less fusible than the pure which is mixed with it, expands in melting and rises out of the mass not yet fused. It is a phenomenon similar to that observed by Mr. Schneider with impure bismuth.

I have stated that the cryolite has been employed here in Berlin under the name of mineral soda for the preparation of caustic soda-ley, which owing to its aluminous earth appears eminently adapted to the manufacture of soap. In fact the pulverized cryolite is decomposed entirely if boiled in this condition with caustic lime and water. The fluorid of calcium thus generated contains no aluminous earth, this being entirely dissolved in the hydrate of soda, which again is free from fluorine or shows but a trace of it.

ART. XXI.—*On a new Species of Unio;* by T. A. CONRAD.

Unio diversus.



Trapezoidal, ventricose, inflated posteriorly, substance of shell generally thin, thicker anteriorly and thickest or somewhat callous towards the base; valves contracted from beak to base, posterior margin obliquely truncated, rectilinear, ligament and basal margins parallel; posterior extremity obtusely rounded; basal margin contracted; umbonal slope rounded; beaks decorticated; lines of growth profound; epidermis yellowish olive clouded with dark brown; rays obsolete or wanting; within greenish or wax-colored; dirty white towards the anterior base; cardinal tooth in right valve compressed, oblique, crested, prominent; in the opposite valve 3-lobed, the posterior lobe opposite the apex, middle lobe small or obsolete; lateral teeth straight, reversed.

Inhabits Shoal Creek, N. Alabama. Prof. Thomas P. Hatch.

Remarkable for its resemblance to *U. heterodon*, Lea, and like that species having the double lateral tooth in the right valve. The cardinal tooth of the left valve has the same extended character as the *heterodon*, and I think these two species will be found to constitute a distinct subgenus when the animals have been compared.

U. viridis, Raf. Perhaps it may interest conchologists to learn that this species inhabits the Schuylkill river, at Phœnixville, where I found three specimens in a very limited time; and some years since I procured a number of living specimens in the Delaware, opposite Trenton, just below the falls.

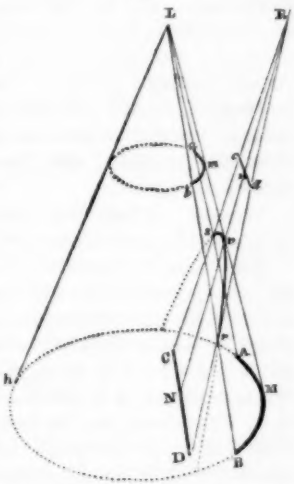
ART. XXII.—*Observations on Binocular Vision;* by Professor WILLIAM B. ROGERS.

(Concluded from page 95.)

29. *Of the form of the curve resulting from the binocular union of a straight line with a circular arc or of two equal circular arcs with one another.*

A. *Binocular resultant of a straight line and a circular arc.* Assuming the optical centres of the two eyes L and R, figs. 74 and 75, as fixed during the act of combination, it is evident that the centre of the eye directed to the circular arc *a b* or A B may be regarded as the vertex of a cone whose surface includes all the positions of the optical axis of that eye as successively directed to the different points of the arc. This cone will of course be right or oblique according to the direction in relation to the plane of the paper, of the line joining the optical centre with the centre of the circle of which the arc is a part. The axis of the other eye in ranging from end to end of the vertical line *c d* or C D vibrates in a plane R C D which during the binocular combination intersects the conical surface, in an attitude depending on the distance between the optical centres, the place of the diagram, and the position of the component lines, *a b*, *c d*... or A B, C D.

74.



The two optical axes directed each moment to corresponding points of the vertical line and the arc, as *m*, *n* .... *a*, *c* .... *b*, *d* or M, N .... A, C .... B, D, &c., meet in the conical surface, forming optically a series of resultant points, *v*, *s*, *r*, &c., which together constitute the binocular resultant curve. *This curve must therefore be a conic section*, the nature of which will depend on the direction of the cutting plane in reference to the conical surface. The effects of the several conditions of the experiment will be seen more clearly by considering separately each of the following cases which taken together include all the variations that can occur.

First. When the arc is *convex* towards the right line and the two are combined by directing the optic axes *beyond* the plane of the diagram.

These conditions are represented in the upper part of fig. 74. Here the arc *a b* and right line *c d* have for their binocular resultant the curve *r v s*. Since the points *m* and *n* unite optically at a less distance behind the diagram than any other pair of corresponding points in *a b* and *c d*, it follows that the vertex *v* in which they combine must be the point of the resultant curve, nearest to the observer, and as the curve lies wholly in the plane R C D it must therefore present its convexity *obliquely forwards*.

According to the proportions assumed in the figure, the line R *v* N is more steeply inclined than the line L *h* to the base of the cone, and in these conditions therefore the curve *r v s* is an hyperbola. But by placing *a b* and *c d* a little nearer one another we may cause R N to become parallel to L *h*, in which arrangement the resultant will be a parabola; and if we bring *a b* and *c d* still nearer together so as to make R N converge downwards towards L *h*, we transform the curve *r v s*, into an arc of an ellipse. In the conditions included in the first case therefore the binocular resultant may have the form of either of the curves just mentioned.

Second. When the circular arc is *concave* towards the right line, and the two are united in *front* of the plane of the diagram.

This case is represented in the lower part of fig. 74. Here the component lines are the circular arc A B and the right line C D, which by cross-vision are made to unite in front of the plane in which they are placed in the experiment. The resultant curve *r v s* will evidently vary in form according to the distance between A B and C D. As shown in the figure this curve is an hyperbola, but by *increasing* the interval between A B and C D it may be converted into a parabola or into the arc of an ellipse. Thus in the conditions of the second case also the binocular resultant may have the form of either of these curves.

Third. When the circular arc is *concave* towards the right line and the two are binocularly combined *behind* the plane of the drawing.

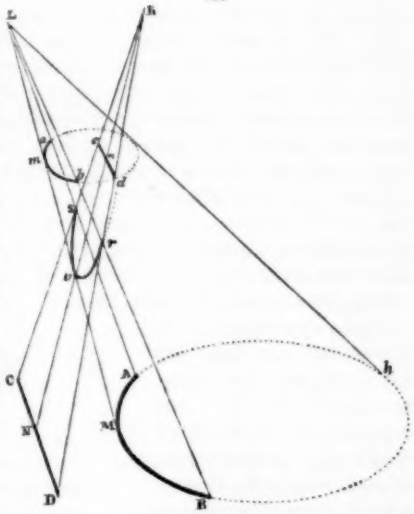
The combination here specified is shewn in the upper part of fig. 75. In this case the vertex of the resultant curve *r v s* being formed by the optical union of the two points *m* and *n*, of the component lines which are farthest apart, must be at a greater distance behind the plane of these lines than any other point of the resultant; and since the curve *r v s* lies entirely in the plane of R C D it must always turn its convexity *obliquely away* from the observer. As the optical conditions here supposed require that R *n* produced shall intersect L *m* produced, it follows that the plane R *c d* when extended will pass *entirely through the cone*. In this case the resultant curve can never be either a hyperbola or parabola but must be an elliptic arc, varying in form according to the interval between *a b* and *c d*. Where the visual cone is

oblique as is most likely to happen, the curve *r v s* will of course become an arc of a circle whenever the cutting plane takes the position of the *sub-contrary section.*

Fourth. When the circular arc is *convex* towards the right line and the two are combined in *front* of the plane of the diagram.

The conditions here referred to are exhibited in the lower part of fig. 75. In this case A B and C D are the component arc and right line, and *r v s* is their binocular resultant formed by cross-vision in front of the plane in which they are presented to the observer. Since in this mode of combination the optic axes are required, for all points of the resultant, to intersect somewhere between the plane of A B C D and the eyes, it is evident that the plane R C D must pass entirely through the cone. Hence the resultant curve *r v s* must be an arc of an ellipse. As in the preceding case the form of the ellipse will vary with the distance between A B and C D, and it will become circular in the position of the sub-contrary section.

75.



These various effects of the binocular union of a right line with a circular arc may be thus summed up.

(*a.*) When the arc is *convex* to the right line and the union is effected *beyond* the plane of the diagram, or when the arc is *concave* to the line and they are combined *in front of* the diagram, the binocular resultant may be either an *ellipse, a parabola, or an hyperbola*, but in either case it will turn its *convexity obliquely towards the observer.*

(*b.*) When the arc is *concave* to the right line, and they are united *beyond* the plane of the diagram, or where it is *convex* to the line and they are combined *in front of* the diagram the binocular resultant is always *an arc of an ellipse* turning its *convexity obliquely away from the observer.*

B. *Binocular resultant of two circular arcs.*

In this as in the preceding combinations the optical centres are to be regarded as immoveable during the experiment. Each eye

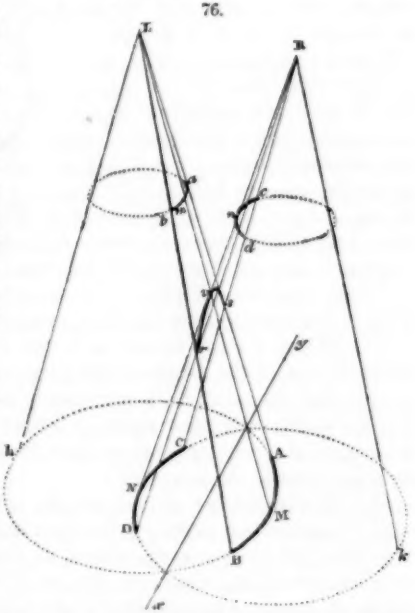
while viewing the successive points of the arc presented to it, revolves in such a manner as to carry its optical axis around in a conical surface. Thus two conical surfaces are generated, having for their respective apices the centres of the two eyes and including all the directions which the optical axes assume in combining the successive pairs of corresponding points of the circular arcs. In general terms therefore *the binocular resultant in all such cases may be described as the curve line in which the surfaces of the two visual cones intersect one another.*

It is only however under special conditions that the resultant thus formed is *a plane curve.* When the circular arcs presented to the two eyes are of unequal curvature the visual cones, by their intersection produce a curve which cannot be included in a plane but lies in an inflected surface, and this accordingly is the form which the resultant takes whenever circular arcs of *unlike* curvature are combined either with or without a stereoscope.

In what follows the figure and position of the resultant will be considered under the simplest conditions, viz.: *when the circular arcs have equal carvature and are so placed that the intersecting conical surfaces are precisely alike.*

These conditions are represented in figs. 76 and 77, where the circular arcs *a b* and A B are respectively of the same length and curvature as *c d* and C D, and are supposed to be so placed that the visual lines directed to the several points of one arc shall be equal to those which are directed to the several points of the corresponding arc; thus making L *a* ... L *m* ... L *b*, &c., respectively equal to R *c* ... R *n* ... R *d*, &c., and in like manner L A ... L M ... L B equal to R C, R N, R D, &c.

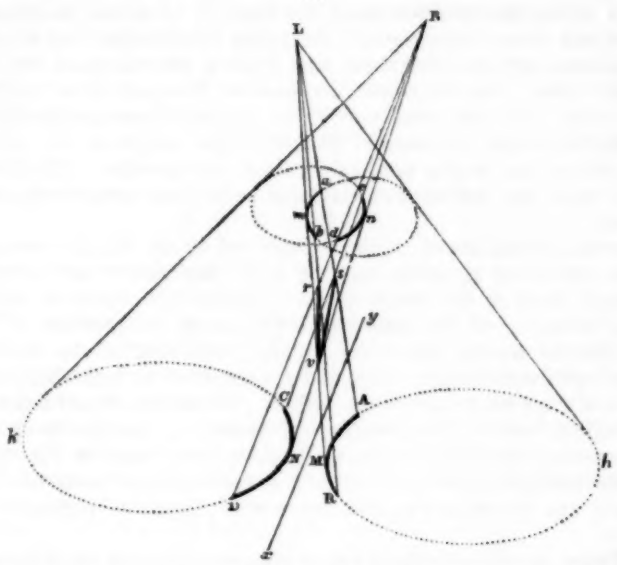
76.



From this construction it follows that the corresponding or intersecting visual lines L A and R C ... L M and R N, &c., are equally and oppositely inclined to the plane of A B C D or *a b c d*. Hence each point of the resultant curve as *r* ... *v* ... or *s*, is placed

at the apex of an isosceles triangle D *r* B ... N *v* M ... or C *s* A formed by the lower segments of the visual lines.

77.



Let us now assume a line *x y* midway between M and N and parallel to tangents at these points, and let us imagine a vertical plane including this line to extend indefinitely upwards. Since *v* is vertically over the middle of M N and *r* ... *s* and the other points of the resultant *r v s* are similarly situated in regard to lines parallel to M N and connecting the two arcs, it follows that *v* ... *r* ... *s*, &c., are situated vertically above the line *x y*, and therefore that the *resultant curve* lies in the before-mentioned *vertical plane.*

In combinations of this kind, as in the case of the right line and circular arc, elsewhere explained, the particular form and attitude of the resultant will depend on the aspect in which the two arcs are presented to one another, and the place, in regard to the plane of the diagram, in which they are combined. In fig. 76 we have the resultant as produced either by the union of mutually convex arcs beyond the plane in which they are situated, or of concave ones in front of it. In fig. 77 we see the resultant of mutually concave arcs behind or of convex ones in front of the plane of the components.

In the former case, the resultant curve as represented in the figure is an *hyperbola.* But if we suppose the component arcs

to be so placed that the outer sides L *h* ... R *k* of the visual cones are vertical the resultant becomes a *parabola*, and if we imagine this change to be carried so far as to make these sides converge downwards, the resultant takes the form of an arc of an *ellipse*. As *m* and *n* are the points of the upper component arcs which are nearest together, their resultant point *v*, the vertex of the resultant curve, must be nearer the observer than any other part of the curve; and the same conclusion follows from considering *v* as the binocular resultant of M and N, the points of the lower component arcs which are farthest from one another. Hence in both cases the resultant curve must be convex towards the observer.

In the conditions of union represented in fig. 77, the vertical plane extending upwards from *x y* must necessarily pass entirely through both of the visual cones. Hence the resultant curve *r v s*, which is at the same time the line of intersection of the two conical surfaces with one another, and that of the vertical plane with each surface, cannot be a parabola or hyperbola, but must always be an arc of an ellipse. From the construction it is evident that *v*, the resultant of *m* and *n*, the points of the upper component arcs which are farthest apart, must be the point of the resultant curve *r v s* which is most distant from the observer, and therefore that the curve will present its concavity in front.

These several effects of the binocular union of circular arcs of equal length and curvature, may be thus summed up.

(*a*.) When the arcs are *convex* to one another and they are combined *behind* the plane of the components, or when they are *concave* to one another and combined *in front* of this plane, *the resultant may be either an hyperbola, parabola, or ellipse, but in either case it will be convex towards the observer, and situated in a vertical plane.*

(*b*.) When the arcs are *concave* to one another and they are combined *behind* the plane of the components, or when they are *convex* to one another and combined *in front* of this plane, *the resultant is always an arc of an ellipse concave towards the observer and situated in a vertical plane.*

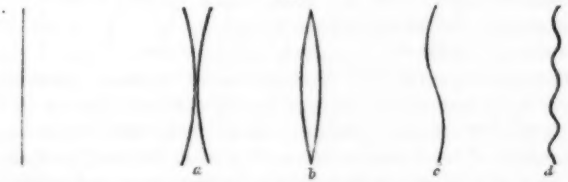
It is scarcely necessary to add that in either of these cases, as in the combination of the right line and circular arc, wherever the resultant curve takes the position of the sub-contrary section it becomes the arc of a circle.

30. *Further examples of the union of right and curve-line figures of equal height.*

From what has been shown of the combination of a right line with a simple arc (27) and of the union of such a line with a figure composed of several right lines (24), we may infer

the effect which will result when a right line is combined with a figure composed of two or more curves. When the breadth of the latter is so small as to allow of a very rapid alternation of union, the resultant presents itself in perfect relief, at the same time apparently in every part. This is well shown when the vertical line, fig. 78, is combined with either of the compound

78.



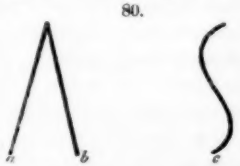
curve figures *a*, *b*, *c*, *d*. When combined with *a* it gives a resultant consisting of two curves (conic sections) in relief with their vertices touching, with *b* the effect is that of two curves like the former uniting to enclose a perspective plane, with *c* it presents a sigmoid line turned somewhat edgewise towards the view and with *d* an undulating line in a similar position.

A remarkable example of this kind of combination is furnished by fig. 79 which from its bearing on an observation of Prof. Wheatstone to be cited hereafter is deserving of more particular mention. Placing *a b* before the left and *c* before the right eye, we may readily unite either of these lines with the sigmoid *e* and with a slight change of optical convergence pass from the one combination to the other. In each case as might be expected the resultant is a deeply inflected doubly-curved line in a perspective attitude.

79.

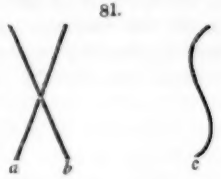
Even when the bent line has the rapid flexure represented in fig. 80, we have no difficulty in producing the alternating union of *a* and *b* with parts of the sigmoid which are not too greatly inclined to these lines. In making this experiment it will be observed that while we readily succeed in combining *b* with the whole length of *c*, excepting a short distance at each end, we cannot at any one time produce an entire union of *a* with *c*. We may however by separate efforts combine the two upper or the two lower halves of these lines successively. This difference is explained by the fact that the distances between the corresponding points of *b* and *c* do not

80.



greatly vary throughout these lines, while between *a* and *c* they are much greater for the lower than the upper halves. The same remarks apply to fig. 81, except that in this case it often happens that the upper half of *a* and the lower of *b* or the upper of *b* and the lower of *a*, unite simultaneously or nearly so with the corresponding parts of *c*. In all these cases of course the union does not extend to the extreme parts of the lines.

81.



In consequence of the fluctuation of optical convergence whether spontaneous or voluntary, the various modes of union above described present themselves in irregular alternation, but the easiest of these combinations, that of *b* with the whole of *c*, is the one which most frequently occurs first and which continues longest.

The experiment of Prof. Wheatstone referred to above, includes, it will be seen, the same conditions as that last described. It was as follows. He presented the letters and drawn of equal height and enclosed in equal circles, one to each eye. On attempting to combine them, he says, "the common border will remain constant while the letter within it will change alternately from that which would be perceived by the right eye to that which would be perceived by the left eye alone. At the moment of change the letter which has just been seen breaks into fragments while fragments of the letter which is about to appear mingle with them and are immediately after replaced by the entire letter." (Phil. Mag., April, 1852.)

In repeating this experiment with the figure appended to Prof. Wheatstone's memoir and bringing the letters together either with or without the stereoscope, and by convergence of the axes either beyond or in front of the paper, I have never failed to remark *partial and capricious binocular combinations* between the corresponding portions of the two letters, as in the cases above described. In these circumstances most of the A disappears in the resultant and sometimes, especially when the eyes are fatigued, the whole letter seems for a moment to vanish. The upper or lower part of the heavy stroke of the S and sometimes the whole of this part of the letter are thrown into perspective and greatly changed in shape and attitude, but I have very rarely observed it to disappear.

As from the small size of the letters in Prof. W.'s figure, and the rapid changes of combination thence resulting, I have found it difficult to mark the phenomena distinctly, I prefer using let-

ters of the size and form of fig. 82, omitting the enclosing circles as unessential to the experiment. With this I find the union of the heavy part of the one letter with that of the other to take place at once; while the other combinations of a more partial kind require a special effort. Substituting the letters D . . . V of the same size as in fig. 82 equally striking effects of partial combination may be observed.

82.

In these experiments the observer cannot fail to notice the occasional invisibility of parts of lines when very near to others but not quite coincident with them. This effect, first pointed out by Sir David Brewster, has no doubt an influence in the seemingly capricious changes above described, which as a class this philosopher has so well designated by the name of *ocular equivocation*. But judging by my own visual experience in the analysis of the phenomena, I am satisfied that most of the changes which present themselves in such cases, including the apparent breaking up and reunion of parts of letters mentioned by Prof. Wheatstone, are really due to imperfect and shifting combinations of portions of the one letter with those of the other. As it is the general and necessary incident of binocular combination that each component line or part of a line is seen only in the binocular position and as merged and included in the resultant, we *should expect* in the present case to lose sight of the component right line as a right line and to see the curve only in its changed shape and attitude. It seems to me therefore that *the shifting appearances* in Prof. Wheatstone's experiment as well as in all other attempts at uniting complex and very dissimilar pictures, *arise in a large degree from alternating combinations between parts capable of binocular union and cannot be ascribed except very partially to the actual vanishing and re-appearing of the components.*

SECOND.—*Of the binocular union of figures differing both in height and breadth.*

Having in the preceding section considered the laws of binocular combination in the case of figures of equal height, but differing in breadth, I now propose to examine briefly the conditions of apparent coincidence where the figures are unequal in both dimensions.

31. *Phenomena of vertical binocular adjustment.*

In referring to the binocular combination of vertical lines slightly differing in height, and whose lower ends are placed on the same horizontal level, it was remarked (6) that a slight turn-

ing of the head sufficed to unite the upper extremities and that this movement when very small was made almost unconsciously. But while this adjustment explains in certain cases the optical coincidence of points and lines situated at unequal distances above or below the horizontal direction, it does not apply to the cases in which the head is kept perfectly fixed during the act of combination. In these conditions the coincidence would seem to result from a vertical rotation of one or both eyes, or perhaps an equivalent change in the direction of the transmitted pencil due to some alteration of the form of one or more of the refracting surfaces. As such an adjustment has not, I believe, been suggested by preceding writers on vision, the following details founded on personal observation may, it is hoped, throw light upon the subject.

Recurring to the experiment mentioned under a former head (6) and using a similar diagram (fig 83), I place it beyond the

83.

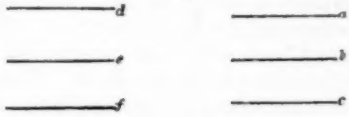
limit of distinct vision, so that the optic axes directed crosswise to its right and left sides may intersect in front of the diagram at that limit. I now adjust the lines so as to be visually horizontal and proceed to unite them by directing the right eye towards *b* . . *c*, and the left towards *a*. In doing this I find as formerly stated, that *a* and *b* readily coalesce. I then turn the paper so as slightly to depress *a*, and repeating the effort I observe *a* taking a position just beneath and close to *b*, but quickly after uniting with it. Turning the paper still further in the same direction, until by the usual convergence I bring *a* below *b* and midway between this line and *c* I find that with some effort I can still cause the two to unite. Lastly, I depress *a* a very little more, so that the converging action may carry it below the middle of the interval between the other lines, and now I see it quickly coalesce with *c*. Usually this union does not take place instantly unless *a* is brought to the same level with *c*—that is, to such a position that the corresponding ends of the two lines are in the same horizontal direction. The effect in this case, is a little different from that of the experiment formerly described (6) where the axes were made to intersect much nearer than the limit of distinct vision, as in the present conditions the action of the two eyes is more nearly equal. It should be remarked also that the limit of vertical separation compatible with a union of *a* with *b* or *c* is liable to considerable variation, especially when the eyes have become fatigued by the experiment.

It would appear from these results that the eyes possess an adjusting power which enables them to unite two lines or points

situated at different heights above the horizontal direction, even when the optical centres are kept in a fixed horizontal position. In my own case moreover it is evident that the range of vertical adjustment is much greater when the object viewed by the right eye is the lower of the two than when their relative altitudes are reversed. From what I have noticed in the experience of other observers I am disposed to conclude that a like inequality of adjusting movement is of common occurrence, having in some cases the same relation to the right and left eyes as that above described, and in others the reverse. The effect of the vertical adjusting power however, is obviously the same whether we consider it under either of these conditions or as having equal range above and below a perfectly horizontal line.

In order more completely to study its action in producing the apparent coincidence of figures of unequal height, I use the system of parallel lines shown in fig. 84. Holding this at a distance

84.



in such position that all the lines shall be visually horizontal and bringing together the parts of the figure by cross vision, I remark that the lines of either of the pairs *a d . . . b e . . cf* to which the view is for the time directed appear to coalesce, and that they continue united as long as the attention is fixed upon them; at the same time the lines of the two other pairs are seen not to coincide. Thus, when I fix my eyes on *a d* during the convergence I see them united as a single line, but while this union is maintained, *b* appears just below *c* and almost touching it, and *c* above *f* at a greater interval. Directing the view to *b c*, these lines become coincident, while *a* takes a position slightly below *d*, and *c* above *f;* and so when I unite *c f* each of the other pairs appears as two closely adjacent parallel lines. In this figure the interval from *d* to *c* exceeds that from *a* to *b* by about the fifteenth of an inch; and the interval from *c* to *f* exceeds that from *b* to *c* by about one-thirtieth. When the lines *a* and *d* are more nearly equidistant above the horizontal and *c* and *f* below it, the vertical adjustment necessary for the successive union is so quickly effected that *the coincidence appears to take place simultaneously throughout all the pairs.*

32. *Explanation of these phenomena by a vertical rotation associated with the converging movement of the eyes.*

To show in what manner the hypothesis of a vertical rotation of one or both eyes may be applied to explain these phenomena, let us suppose *m* and *n* to be the central points of the retinas of

the two eyes L and R, fig. 85, and let us assume that while the optical centres of the eyes are fixed in a horizontal position the lines *a*, *d*, . . . of fig. 85 are adjusted to paralellism with this

85. 86.

direction. Further let us assume that in converging the axes by cross vision to bring *a* and *d* together, there is an entire absence of vertical rotation. In this case if the axis of the eye R be directed to the line *d* which is on a higher level than *a*, the axis of L will pass above *a*. Thus the picture of *d* will fall *centrally* on the retina of R, and that of *a above* the retinal centre of L. If again we suppose both axes to range in a horizontal line midway in height between *a* and *d*, fig. 86, the pictures of *a* and *d* will fall *at equal distances* respectively *above* and *below* the centres *m* and *n*. In all these cases the vertical distance between *a* and *d* on the two retinas will be the same. Under these conditions it is impossible according to received laws of vision that the two images should produce a single perception, in other words, that *a* and *d* should appear as a single line.

If now we imagine a slight vertical rotation of one or both eyes, during or at the close of the ordinary converging movement, it is easy to see that the images *a* and *d* may be made to cover the centres or other corresponding parts of the retinas above or below. In the case of fig. 85, we may suppose the left eye to revolve so as to carry the centre *m* up to *a*, while the other centre *n*, is kept fixed in its coincidence with *d*. In the case of fig. 86, we may imagine the left eye to rotate upwards and the right downwards, until *m* and *n* are brought severally to coincide with *a* and *d*. Thus the pictures of the two lines would make their impressions centrally on the two retinas, and might be expected according to known laws of vision to give rise to the perception of a single resultant line.

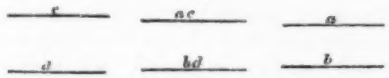
It is to be observed that in this adjustment the two optic axes do not actually meet or intersect but pass by one another at a very small interval where nearest together. The *distance* which we usually assign to the resultant is evidently determined by the point of closest proximity of the axes, and its position as to height is midway between the upper and lower components, supposing these to have been brought by ordinary convergence to be vertically one above the other. According to this view the law of binocular direction would apply to the vertical as well as the horizontal inclination of the optic axes, so that when in the above experiments the two lines are made to appear as one by the com-

bined action of both kinds of adjustment, we perceive the resultant in a direction which is the binocular direction both as regards the vertical and the horizontal plane.

In the above experiments the effects described are obtained by crossing the axes, and so as to form the resultant in front of the picture, but similar phenomena present themselves when the combination is made behind the picture. Any further reference to the latter is therefore unnecessary.

33. *Why the height of the resultant is a mean of the heights of the component figures.*

87.

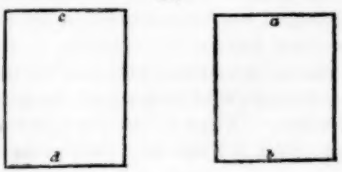


If in combining *a* with *c*, (fig. 87,) by the process before described, we also keep in view the lateral images of these lines formed one in each eye we find that the resultant takes a position midway in vertical as well as in horizontal direction between the lines *a* . . *c*, thus laterally seen, and a similar effect occurs in uniting *b* with *d*, and when the difference of level of these lines is so small as to allow the vertical adjustments to be made in quick succession we perceive both resultants apparently at the same time in their positions of midway elevation as shown in the lines *a c* . . . *b d*, of the figure.

It is readily seen that this visual reference of the resultant to the position of mean height between the components, is due to the same vertical adjustments which cause the images of the latter to fall severally on the centres of the two retinas. Thus when the axis of the right eye is directed to *c*, (fig. 87,) and the picture of this line is formed centrally on the right retina that of *a* will of course take a position in the same eye laterally to the left and at a higher level on the retina. Hence *a* as laterally seen will appear to the right and lower than *c*, as seen centrally. So in regard to the left eye, *c* laterally seen will appear to the left and higher than *a* seen centrally. But as in virtue of the binocular union of the central images of *a* and *c*, these lines as centrally seen appear to occupy but one place, viz., that of the resultant, it follows that *c* laterally viewed must appear higher, and *a* similarly seen, lower, than this resultant.

If now *a* . . . *c* and *b* . . . *d* be made the upper and lower sides of two rectangles, figure 88, we may effect the union of these figures by the same adjustments as in the previous experiments, and in this case the resultant or binocular figure will have

88.



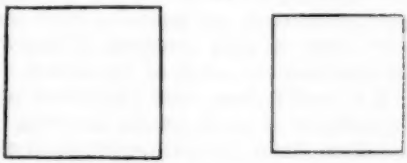
a height intermediate between that of the two figures seen laterally at the same time, in other words, between the left and right pictures of the diagram. This conclusion, it will be observed, corresponds, so far as vertical effect is concerned, with the observations of Prof. Wheatstone, cited on a previous page.

34. *Limited range of the vertical compared with the horizontal power of combination.*

The details which have been presented indicate the narrow limits within which the power of vertical adjustment and combination is restricted as compared with those of binocular combination by ordinary convergence. Hence in combining figures which differ to the same extent in the horizontal and vertical directions, we generally find that while the coincidence on the right and left sides of the resultant is perfect and apparently simultaneous, the union at the top and bottom is but partial and is obviously successive. Indeed it is only *when the disparity of heights is very inconsiderable* that the combination appears to be equally complete in all parts of the resultant.

As an example of this, in attempting to unite the two squares of fig. 89, with the precautions as to adjustment before described, I find that while the vertical sides of the resultant figure appear each as a perfectly clear and distinct single line, the lower side appears double until the view has been fixed upon it for a sensible time and that on carrying the eyes to the top of the resultant this side also seems for a moment to be double. When however, the disparity between the heights is reduced to half the amount in the figure the upper and lower sides of the resultant present themselves in the shape of single lines as immediately and to all appearance as simultaneously as the vertical sides, and of course the resultant figure appears of a height intermediate between that of the right and the left hand figures. Like effects are exhibited by unequal circles and other pairs of figures geometrically similar.

89.



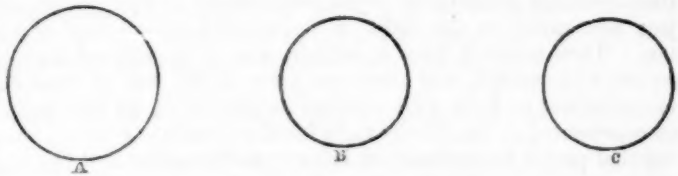
35. *Perspective position and usually warped figure of the resultant.*

We have seen in the preceding section that when figures of unequal horizontal breadth are united binocularly they form a resultant having an oblique or more or less perspective position. This effect must evidently occur in the case of unequal squares or circles or of any other figures differing in *breadth* as well as height. Thus when by cross vision I combine the squares of fig. 89 I see the left hand side of the resultant figure nearer to

me than the opposite side, so that the whole has an oblique or perspective attitude either as a plane or concave surface. At the same time the near side appears shorter than the other as in cases previously explained, (fig. 44,) and thus the resultant of the two squares is visually a quadrilateral of *unequal sides.*

In combining by the same process the two unequal circles A . . . B, fig. 90, the left hand side of the resultant appears nearer

90.

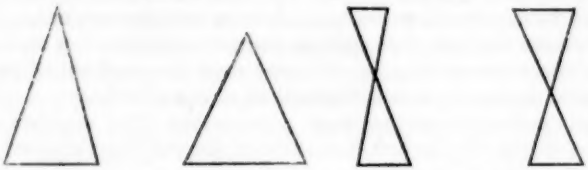


than the other and is concave while the other is convex, giving the figure an oblique position and a strangely warped appearance. This effect is made more striking if we combine the equal circles B . . C and the unequal ones B . . A in quick succession, in which case the oblique and twisted resultant of B A forms a marked contrast with the perfect circle which lying in a plane at right angles to the binocular direction results from the union of B and C. In the figure, the circles are placed at equal intervals in order that the same crossing of the optic axes may serve to effect both combinations and that the reader may have the advantage of comparing the resultants side by side.

When by cross vision we bring together the similar triangles A B, fig. 91, we observe towards the apex of the resultant a peculiar twist of the surface by which the right side is then thrown obliquely behind the other, and as we carry the view to the base of the figure and back again to the apex, the whole resultant takes the shape of a warped surface not unlike that of the mould board of a plow. By turning the diagram until the vertex of B is brought to the horizontal visual line the resultant is converted into a plane figure at right angles to the binocular direction, but containing the bases of A and B as separate parallel lines. A yet more remarkable flexion of surface is produced by combining the triangles of fig. 92, which are at the same time unequal and *dissimilar*, or by uniting the double set of unequal triangles forming fig. 93.

91.

92. 93.



The association of unequal vertical rotation of the eyes with their ordinary converging adjustment occurs in viewing an object very much to the right or left of the medial line of vision. Thus when I hold a straight wire in a vertical position on the extreme left, and direct my view to the wall at some distance behind it, I see two unequal pictures of it on that surface as represented in fig. 94, the right hand or longer line being that proper to the nearer or left eye and the other that proper to the right eye. It is obvious that to see the wire single while in this position the same optical adjustments must be made as in uniting these two unequal pictures of the wire, and thus therefore vertical rotations differing for the two eyes either in amount or direction are as necessary in this case as in preceding experiments.

94.

In referring to the results of oblique vision as related to the union of unequal figures, Prof. Wheatstone remarks that "were it not for the binocular coincidence of two images of different magnitudes objects would appear single only when the optic axes converge forwards," &c. (Philos. Trans., 1838.) Sir D. Brewster on the other hand maintains that the apparent coincidence of unequal figures arises from an actual disappearance of one of them and that "in very oblique vision one of the eyes resigns its office and leaves the other to view the object distinctly and singly." (Phil. Mag., 1844). As regards the latter explanation I have before endeavored to show that the fitful vanishing and reappearing of parts of the figures often observed in these experiments is not directly connected with the development of the resultant (19), and that this latter actually includes both the components. In further support of this view, I would here adduce the fact, above proved, of the *intermediate magnitude* of the resultant figure. This seems to mark the visual perception as *binocular*, and not as the result of either impression singly, and to indicate that *the two retinal images are equally concerned in the single perception which is produced.* The sense of binocular direction attending these combinations is also in favor of this view.

In respect to the conditions of the binocular coincidence perceived in these combinations, I conclude from the preceding ob-

servations that unequal vertical images or equal ones not correspondingly placed in the eyes do not of themselves and directly produce the single resultant perception, that the coincidence however seemingly simultaneous for all parts of the figure is really the effect of rapidly successive adjustment applied to the vertical and horizontal elements of the diagram, and that this process applied *partially or throughout*, according to circumstances, gives rise by suggestion, to the mental resultant.

Other observations bearing on this subject are now in progresss more especially as regards the union of pictures seen in Dove's experiment by instantaneous or electric light, but they are not sufficiently matured to be communicated at this time.

ART. XXIII.—*Abstract of a Meteorological Journal kept at Marietta, Ohio, for the year* 1855—Lat. 39°·25′—Long. 4°·28′ West of Washington City; by S. P. HILDRETH.

MONTHS.	THERMOMETER.						Winds.	BAROMETER.		
	Mean temperature.	Maximum.	Minimum.	Fair days.	Cloudy days.	Inches of rain and melted snow		Maximum.	Minimum.	Range.
January, . . .	35·23	65	12	12	19	2·50	S. W. & W.	30·10	28·45	1·65
February, . . .	26·17	58	6	9	19	1·50	N., & W. N. W.	29·75	28·85	·90
March, . . .	37·80	66	4	16	15	2·67	W., N. & S.W., E.	29·75	28·80	·95
April, . . .	55 33	91	18	20	10	2·08	S., S. W., & N.	29·85	29·10	·75
May, ...	61·41	90	32	20	11	5·17	W., S.W., N. & E.	29·58	29·00	·58
June, ...	66·81	97	42	13	17	5·68	S. & S. W.	29·60	28·90	·70
July, ...	75·84	96	52	18	13	6·00	S., N. & E.	29·70	29·25	·45
August, . . .	73·97	94	48	18	13	3·09	S., N. & N.W., E.	29·75	29 15	·60
September, . .	70·36	91	42	15	15	8·00	S. W., & E. S. E.	29·65	29·20	·45
October, . . .	50·14	75	28	20	11	1·85	S.W., & W.N.W.	29·55	29·08	·47
November, . . .	48·08	75	20	16	14	3 55	S. E. & N. W.	29·65	28·90	·75
December, . . .	33·66					3·65				
Mean, . . .	53·15					45·75				

Remarks on the year.

THE year 1855 exhibits a strong contrast to that of 1854, in several particulars, but more especially in the temperature, and amount of rain. Last year was noted for its excessive heat and great lack of moisture. The drought of the preceding year was continued into the following one. As late as the last of April and the first of May, people began to express their fears of another season of drought and heat which would in a manner ruin the country. The first four months affording less than nine

inches of rain, an amount which has sometimes fallen in a single one. But in May, rain began to descend abundantly, so that in this and the three following months there fell nearly two feet, being twelve inches more than fell in the same months in 1854. Such a quantity had not fallen before in many years. This abundant supply had an astonishing effect on the crops. Wheat, Indian corn and grass sprang up with renewed energy, yielding an amount of produce unprecedented in the annals of Ohio. Wheat turned out, in some instances over fifty bushels to the acre. Indian corn on the uplands afforded as many bushels, as in ordinary years are grown on the rich bottoms; in one instance reaching the enormous quantity of one hundred and fifteen bushels. The stalks attaining a great height, even to twenty feet, loaded with ears, filled to their extremities with grain. This was the greatest growth known in the valley of the Ohio, and was in part occasioned by the preceding drought, pulverizing and warming the earth to an unusual depth, affording a loose mellow soil for the roots of plants to descend deeply, and thus acquire more food than usual. This light porous condition of the earth was noticed by all the farmers in plowing their lands in March and April. The meadows also yielded abundantly, but much of the hay was injured by excessive rains in July, with a lack of sunshine to cure it. A great quantity of wheat was sprouted or germinated, after it was cut and placed in shocks, before the weather would allow of its being stacked or put away in the barn. August was less wet, having only half the quantity of July—while September, usually a dry month, exceeded any other in the year, affording eight inches. The rivers, from early in the spring to the last of December, were in the best condition for boating, not lacking a sufficiency of water all through the summer and autumn. The great rains of September filled to overflowing the small rivers and creeks, causing much damage to the crops of corn and potatoes on the bottoms, a circumstance rarely if ever known before. Fruit of all kinds was abundant, especially apples and peaches. The grape crop was much injured by the excess of wet, many of the berries perished, leaving the bunches small, while the juice lacked saccharine material. It is a calamity, to which our vineyards will be liable in wet seasons, until the ground on which the vines are planted is deeply trenched and ameliorated by underground drainage. Sweet potatoes were abundant, of a good quality, but not so rich in sugar as in dry seasons. Irish potatoes were excellent in every respect. Beans, an important crop, along the Ohio river, were much damaged by the rains, affording not more than half the usual amount fit for market, occasioning a great advance in their price.

Year.—The mean temperature of the year is 53°·15, being 1°·10 below that of 1854. The amount of rain and melted

snow is 45·$\frac{75}{100}$ in., making about seven inches more than the past year.

Seasons—Winter.—The mean temperature for the winter months is 31°·20, or about two degrees below that of 1854, and is chiefly attributable to the low temperature of February, being no less than eleven degrees and a half colder than this month in that year, the mean for the month being 26°·17; this is below that of any other since the year 1835, when the mean was 25°·00, while in 1834 it was 43°·33, showing a difference of eighteen degrees, in the average of this month. The Ohio river was frozen over early in December, 1854, from the low stage of water being on the 7th day of the month. The winter solstice rains opened it again on the 29th with a rise of ten feet, so that steamboats could run for the first time in several months. It closed again on the 29th January following, with thick strong ice of ten or twelve inches, strong enough to bear loaded teams. In the mean time there fell ten inches of snow. It continued shut up until the 19th Feb., when it again gave way to a rise from rains on the head branches. The river now remained open, but encumbered with floating ice, until the 26th of the month, when it again froze over, and so continued until the 7th of March, closing and opening three times during the winter, while the usual habit of our winters is to shut up the rivers the last of December, and open early in February, when the severe cold ceases.

Spring months.—The mean temperature for spring is 51°·51, which is nearly two degrees below last year. The season was later than usual. Peach trees not in bloom until the 21st April. Pears and plums the 24th. There was a smart frost the 10th of May, killing corn and beans, requiring early fields to be replanted. It was remarked of the apple and peach blossoms, that they were larger and fairer than usual, producing many double peaches and some triplets. It was probably caused by the dry and hot summer ripening and perfecting the fruit buds earlier than common, which therefore were less injured by the cold of winter. The spring months afforded ten inches of rain, more than half of which fell in May, retarding the use of the plow and deferring corn planting to a later period than usual; still, the crops were never more prolific.

Summer.—The season of summer was temperate, with a few hot days, the mean being 72°·20. The mercury rising above 90°, only on three days in June, ten days in July, and four in August, while in 1854, it rose above that point on twenty-six days during these months. The nights were also of a pleasant temperature, and comfortable for sleeping. The rain amounted to nearly fifteen inches, exceeding the former year by five inches. The growth of plants was rapid and uniform, and as they began to

decay, with the surplus of water in the low grounds, the inhabitants in the vicinity of rivers and creeks, suffered from intermittant fevers of a mild type, more generally than for thirty years past.

Autumn.—The mean for this season is 56°·47, which is nearly four degrees above the mean of this period, it rarely reaching this point. September was the most rainy month in the year, there falling eight inches of water, while in 1854, a little over two inches. So much rain injured the potato crop, while it was congenial to Indian corn, filling out the ears to their extremities with grain. The weather continued mild until late in December. The first smart frost was on the 13th of October, temperature at 28°, and not so low again until the 29th of November.

Floral Calendar.—April 2nd, Garden Crocus in bloom; 3d, stalks of Crown Imperial three inches high; 11th, Blackbirds in flocks; 12th, Hepatica triloba; 13th, Early Hyacinth opening, Acer saccharinum; 15th, Dafodill; 16th, Golden bell or Forsythia; 17th, Sanguinaria canadensis; 21st, Peach tree, Pyrus Japon., Hyacinth in full; 22nd, Crown Imperial, Double flowering peach, Spirea prunifolia; 24th, Magnolia purp., Pear tree, Purple plum; 25th, Pie plant fit to cut; 24th, Apple tree, nearer the time of the peach than common by six days; 25th, Red Bud or Judas tree; 27th, Strawberry; 29th, Uvularia.—May 2nd, Apple shedding its blooms; 4th, Tulip in full; 5th, Quince. Peonia arb. purp.; 10th, smart frost, killing corn and beans, with many grapes on the low hill-sides—higher up escaped harm; also some fruit of the apple, peach, &c.; 18th, Locust; 20th, Liriodendron; 21st, Crimson peony; 23d, a tornado from the west, at 6 P. M., blowing down trees and unroofing some buildings; 24th, white peony; 6th, Syringa frag.; 28th, Roses generally in bloom; 30th, Peonia frag.; 31st, Syringa Philad. June 1st, Purple Peony; 3d, Red Raspberry; 5th, first peas on table—planted early in March; 15th, Rosa Grevilia multiflora; 22nd, Catalpa; 27th, early Russian cucumber, in open air, fit to eat; 28th, Red Raspberry ripe.

Art. XXIV.—*Supplement to the Mineralogy of J. D. Dana;* by the Author.—Number II.

Since the publication of the preceding supplement, but few new species of minerals have been announced. The more important works issued are the Russian Mineralogy of von Kokscharov of St. Petersburg, the Mineralogical notices and Annual of Kenngott of Vienna, and the volumes of Volger on pseudomorphism or the alteration of minerals. The principal papers on American Mineralogy are those of Dr. J. Lawrence Smith, on the Minerals of the Wheatley Mine, Pennsylvania, and T. S. Hunt on the Feldspars, etc. of Canada.

1. *List of New Works.*

Axel Erdmann: Lärobok i Mineralogien, 480 pp., 8vo. Stockholm, 1853.—A Manual of Mineralogy in Swedish.

———: Vägledning till bergarternas Kännedom, med Särskild Hansyn till sveriges geologiska Förhaollanden, etc. 206 pp., 8vo. Stockholm, 1855.—An excellent work on rocks, their kinds and structure, and geological relations.

Dr. Adolf Kenngott: Supplement zu dem Werke das Mohs'sche Mineralsystem. 38 pp., 8vo. Wien, 1854.—Presents a synopsis of a classification of minerals on the system of Mohs.

———: Synonymik der Krystallographie. 176 pp. 8vo. Wien, 1855.—A review of the general principles and forms in Crystallography, with the explanations of the terms employed by different authors or systems. The work is especially valuable to any one studying thoroughly the subject of Crystallography.

———: Uebersicht der Resultate mineralogischer Forschungen im Jahre 1853. 174 pp. 4to. 1855, Leipzig. T. O. Weigel.—Kenngott's Mineralogical Annual, gives a full review of the analyses of Rocks and mineral waters, as well as minerals, for 1853.

———: Mineralogische Notizen, which are referred to by their numbers beyond, have reached No. 17. No. 14 is contained in the Sitzungsberichte of the Royal Academy at Vienna, vol. xiii, p. 462, 1854; No. 15, in vol. xiv, 243, 1854; No. 16 in vol. xv, p. 235, 1855; No. 17, in vol. xvi, p. 152, 1855.

Dr. Sigmund Aichhorn: Anleitung zur Flächenzeichnung einfacher Krystallgestalten. 56 pp., 8vo., with 3 plates. Wien, 1855.

G. H. Otto Volger: Versuch einer Monographie der Borazites; eine fassliche angewandte Darstellung des jetzigen Standes der Krystallologie und ihrer neuesten Richtung; Ein Beitrag zur Geschichte dieser Wissenschaft und zur Kenntniss der Steinsalz-Lagerstätten und ihrer Bildung. 244 pp. 8vo. Hanover, 1855.

———: Die Krystallographie. 8vo. Stuttgart, 1854, 1855.

———: Aragonit und Kalzit: eine Lösung der ältesten Widerspruches in der Krystallographie, nebst Untersuchungen über den Asterismus der Krystalle. 64 pp. 8vo. Zurich, 1855.

———: Die Entwicklungsgeschichte der Mineralien der Talkglimmer-Familie und ihrer Verwandten sowie der durch dieselben bedingten petrographischen und geognostichen Verhaltnisse. 634 pp. 8vo. Zurich, 1855.—A work on Pseudomorphous changes, both as to general principles and their applications to special cases, including Calcite, Dolomite, Magnesite, Brucite, Serpentine, Steatite and other examples of pseudomorphism.

F. A. Kolenati: Elemente der Krystallographie. 216 pp., 8vo. Brünn, 1855.

Nicolai von Kokscharov: Materialen zur Mineralogie Russlands. 1st volume complete, and vol. II partly so, with many copper plates.—The figures are numerous and well drawn, the descriptions full, and the measurements of angles show great precision in the use of the goniometer.

J. Schabus: Bestimmung der Krystallgestalten in chemischen Laboratorien erzeugter Producte; von der Kais. Akad. der Wissensch. in Wien gekrönte Preisschrift. 208 pp. 8vo, with 30 plates of forms of crystals. Wien, 1855.—M. Schabus

is one of the best crystallographers (mathematically and practically) of Europe, and it is well for chemistry that he is engaged on the crystals of laboratory products. The work is extensive, the measurements numerous and exact, and the whole crystallization of each product is thoroughly made out and described. The figures are drawn with great precision and beauty. Like the author's Monograph on Euclase, each subject he takes up is finished when it leaves his hands.

B. Cotta: Die Gesteinlehre von Bernhard Cotta, Prof. Geog. zu Freiberg. 256 pp. 8vo. Freiberg, 1855.—A valuable work on rocks.

2. *Crystallography, Formation of Minerals, etc.*

On the Plesiomorphism of Mineral Species; by M. Delafosse. 38 pp. 8vo. Paris, 1854.—This paper, although published in 1854, was read, as it states, at the Academy of Sciences on the 14th of April, 1851. Professor Delafosse brings forward views similar in many respects to those published by the writer in this Journal, vol. xviii; the printing of his paper was a few months later, but in the reading of it, he has the priority. The principal point, and it is one of great interest, is, the relations in angle between species of the inequiaxial systems of crystallization, and the forms of the monometric or tesseral system. Various groups of pseudomorphous species are mentioned, and approximations in angle in hexagonal, dimetric, trimetric and oblique crystals, to the monometric octahedron or dodecahedron, are pointed out.

On the artificial production of mineral silicates and aluminates, by the reaction of vapors upon rocks; by M. Daubrée, Comptes Rend., July, 1854, p. 135, and Phil. Mag. [4], ix, 315.—The author shows that by the action of chlorid of silicon in vapor on the required bases, crystals may be obtained of the species *wollastonite, chrysolite, kyanite, pyroxene* (*diopside*), *feldspars, willemite, idocrase, garnet, phenacite, emerald, euclase, zircon, tourmaline*, besides *quartz*. With chlorid of aluminium on lime *corundum*, in crystals, is obtained, and with magnesia, crystals of *spinel*, etc. Chlorid of titanium affords in like manner *brookite;* perchlorid of iron on lime, affords *specular iron;* or with chlorid of zinc, *franklinite;* and chlorid of magnesium acting on lime affords *periclase*, a known volcanic product.

Solubility of Silica in pure water, &c.; by C. Struckman, (Ann. d. Ch. u. Pharm. xciv, 337).—Hydrated silica being digested in 100 parts of pure water, it lost 0·021 p. c., or $\frac{1}{4\frac{7}{8}}$ p. c. of $\dot{S}i$. Digested in carbonated waters (pure water, through which for 6 days and 13½ hours $\dot{C}$ had been passed), it lost 0·0136 p. c., or $\frac{1}{7\frac{1}{4}}$ p. c., of $\dot{S}i$. Digested in dilute muriatic acid, sp. gr. 1·088, for 11 days in the cold, lost 0·0172 parts, or $\frac{1}{5\frac{8}{9}}$ p. c. of $\dot{S}i$. Hence the loss with pure water was ¼ greater than with carbonic acid and $\frac{1}{5}$th greater than with muriatic acid. Digested in 5 parts of carbonate of ammonia and 95 of water, the loss is 0·02 parts or $\frac{1}{5\cdot0}$ p. c.; and in a very dilute solution of carbonate of ammonia containing only 1 p. c. the loss was 0·062 parts, or about $\frac{1}{1\cdot6}$ p. c. of $\dot{S}i$.

Again 100 parts of liquid ammonia which contained 19·2 p. c. of dry ammonia, the loss was 0·071 parts, or about $\frac{1}{14}$ p. c.; and with only 1·6 p. c. of dry ammonia, loss 0·0986 p. c. or about $\frac{1}{1\cdot0}$ p. c. of $\dot{S}i$.

The results correspond approximately with those of J. Fuchs (Ann. d. Ch. u. Pharm., lxxxii, 119), who found that 100 parts of cold water dissolved 0·013 of $\dot{S}i$, and dilute muriatic acid of 1·115 sp. gr., only 0·009 p. c. of $\dot{S}i$. The obvious conclusions hence are that all ordinary waters may dissolve silica even more than carbonated waters. With the ammonia, the silica is supposed to form a silicate of ammonia.

Calcite: M. Peligot finds that 50,000 parts of pure water dissolve 1 of carbonate of lime. (L'Institut, June, 1855).

On a graphic method of measuring small crystals; by W. Haidinger, (Sitz., Wien, xiv. 1).—The method is proposed for crystals which cannot be otherwise measured, and consists in drawing by the eye lines on paper parallel to the edges or faces of the crystal, as magnified, and measuring the inclination of these lines.

On the Atomic volume, Crystalline form, &c., of the Carbon Spars; F. H. Schröder, Pogg., xcv, 441, 562.

On the Tetartohedrism in the Tesseral System; E. F. Naumann, Pogg., xcv, 465.

On Polymerous Isomorphism; by Th. Scheerer, Pogg. xcv, 497.

Ueber die Ausbildung der Krystalle; by von Frankenheim, Pogg. xcv, 347.

On the formation of crystals with nuclei; H. Kopp, Ann. d. Ch. u. Pharm., xciv, 118.

3. *Descriptions of Species.**

ÆSCHYNITE, see under *Columbite.*

AKANTHITE. Description by A. Kenngott, (Min. Not., No. 16, and Pogg., xcv, 462). Related to Silver Glance. Crystallization, trimetric; forms usually slender and acute, and hence the name from ἀκανθα *a thorn.* A rhombic pyramid, and an acute macrodome $m\bar{1}$, making together an acute double 6-sided pyramid. Shorter terminal edges of the pyramid meeting at the apex in an angle of 50°, and the longer in an angle of 65°; also other planes $i\bar{1}$, $i\bar{1}$, $m\bar{3}$ and $m\bar{3}$. Cleavage indistinct. Fracture uneven, lustrous. H.=2·5 or below. G.=7·31—7·36. Closely like Silver-glance before the blowpipe, fusing easily to a black bead and affording after a while a grain of silver.

Occurs at Joachimsthal with finely granular pyrites, silver-glance and calcite, usually in quartz.

ALLANITE [p. 208].—Analysis of Orthite from Wexiö in Sweden, occurring in red granite with epidote, afforded C. W. Blomstrand, (Oefv. Akad. Förh., 1854, p. 296, and J. f. pr. Ch. lxvi, 156):

$\dot{S}i$	$\dot{A}l$	$\dot{C}e$	$\dot{F}e$	$\dot{Y}$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	$\dot{M}n$	$\dot{H}$ and loss.
33·25	14·74	14·51	14·30	0·69	12·04	0·74	0·29	0·14	1·08	8·22

New loc. at Manchester, N. H., Proc. Boston Soc. N. Hist., v, 189.

ALLOPHANE [p. 336].—Analysis of Allophane from Tennessee, by C. T. Jackson, (Proc. Bost. Soc. N. Hist., v, 120, 1855):

$\dot{S}i$ 19·8 $\dot{A}l$ 41·0 $\dot{C}a$ 0·5 $\dot{M}g$ 0·2 $\dot{H}$ 37·7=99·2

ALUMINITE, see *Websterite.*

AMMIOLITE [p. 142].—A mineral from Chili in red powder, which appears to be the Antimonite of Quicksilver of Domeyko, (ammiolite, D.) has been analyzed by Rivot. He obtained (Ann. d. Mines, [5], vi, 556):

Sb 36·5, Te 14·8, Cu 12·2, Hg 22·2, quartz 2·5, Fe & S *tr.*, Oxygen & loss 12·6.

Rivot observes that from the composition and the reactions, the mineral appears to be a mixture of tellurid of mercury with antimonic acid and antimonate of copper.

ANATASE [p. 121].—A crystal from Tremadoc, Wales, according to Dauber (Pogg. xciv, 407), has the new planes $\frac{1}{3}$, and $\frac{1}{7}$-∞, the pyramidal angles of which, as measured, are 112° 47′ and 159° 58′. Dauber also mentions the occurrence of the pyramid $\frac{3}{7}$, in a crystal from Tavistock in Devonshire.

ANDALUSITE [p. 257].—Crystals of the Andalusite of Lisenz in the Tyrol, according to Kenngott (Min. Not., No. 15), afford the following planes: ∞, ∞-$\breve{2}$, ∞-$\breve{\breve{2}}$, ∞-$\breve{\infty}$, ∞-$\breve{\breve{\infty}}$, 0, 1-$\breve{\infty}$, 1-$\breve{\breve{\infty}}$, 1, 2-$\breve{2}$, or in letters *I*, $i\breve{2}$, $i\breve{\breve{2}}$, $i\bar{1}$, $i\bar{1}$, *O*, $1\bar{1}$, $1\bar{1}$, 1, $2\breve{2}$. Angles: *I*, 90° 50′; $i\breve{2}$, 127° 32′; $i\breve{\breve{2}}$, 53° 48′; $1\bar{1}$, 109° 4′; $1\bar{1}$, 109° 51′; 1, octahedral angles, 119° 31′, 120° 28′, 90° 1′; 2-$\breve{2}$, 135° 6′, 63° 35′, 115° 10′.

New locality in California, Am. J. Sci., [2], xx, 84.

ANDESINE, see *Feldspar.*

ANGLESITE [p. 370].—Analysis of anglesite from Phœnixville, Penn., J. L. Smith, Am. J. Sci., [2], xx, 244.

ANHYDRITE [p. 369].—Structure of crystals from Aussee in Styria, Kenngott, Min. Not., No. 17.

ANKERITE [p. 441].—Analyses of ankerite from the Acadian Iron mines, Londonderry, Nova Scotia, by C. T. Jackson, (Proc. Bost. Soc. N. H., v, 246):

$\dot{F}e\,\dot{C}$	$\dot{M}n\,\dot{C}$	$\dot{C}a\,\dot{C}$	$\dot{M}g\,\dot{C}$	$\dot{S}i$	
23·45	0·80	44·80	30·80	0·10	=99·95
20·30		49·20	30·20	——	=99·70

* The paging following the name of the species, is the number of the page where the species is described in the Mineralogy.

ANORTHITE [p. 234].—Analysis of anorthite from I. St. Eustache, by Deville, (Ann. Ch. Phys. [3], xl, 286 and Lieb. u. Kopp., 1854, 832); specific gravity 2·73:

$\dot{S}i$ 45·8 $\dot{A}l$ 35·0 $\dot{C}a$ 17·7 $\dot{M}g$ 0·9 $\dot{N}a$ 1·0 =100·4

ANTIMONY GLANCE [p. 33].—Loc. in California, Am. J. Sci. [2], xx, 82.

APATITE [p. 396].—Kokscharov, in Min. Russl., ii, 39, (1854), adds the new planes $\frac{3}{2}$ and 3. He figures many new crystals. From his measurements of crystals from the Ural Emerald mine, $O:1=139°\ 41'\ 37''$, the same as from Ehrenfriedersdorf crystals: for crystals from Achmatowsk $O:1=139°\ 53'\ 39''$, same as for the Lake Laach crystals. The Spanish apatite affords 139° 47′.

Analyses: 1. Yellow apatite from Miask, by G. von Rath, (Pogg., xcvi, 331); 2, from the Siegengebirge, R. Bluhme (Verh. nat. Ver., Bonn, 1855, 111, and Ann. d. Ch. u. Pharm., xciv, 354):

	$\dot{P}$	$\dot{C}a$	Ca	$\dot{F}e$	$\dot{A}l$	$\dot{M}g$	$\dot{C}$	$\dot{S}i$	$\dot{H}$	loss
1.	42·08	49·75	3·87	0·16	——	——	——	——	0·17	3·97 =100
2.	37·33	47·50		——	3·28	2·70	2·20	3·50	1·65	1·84 =100

In analysis 1, as 3·87 Ca require 3·62 fluorine, the loss is probably all fluorine excepting 0·35 p. c.

ARAGONITE [p. 448].—An Aragonite in columnar crystallization of unknown locality, *containing fluorine*, afforded G. Jenzsch, (Pogg., xcvi, 145):

$\dot{C}a\,\dot{C}$	$\dot{S}r\,\dot{C}$	$\dot{M}g\,\dot{C}$	$\dot{K}\,\dot{C}$	$\dot{N}a\,\dot{C}$	Ca Fl	$\dot{C}a^3\dot{P}$	$\dot{C}a\,\dot{S}$	$\dot{H}$
91·17	0·27	0·48	0·62	0·59	3·27	1·24	0·86	2·26 = 100·76

Color snow-white. G.=2·830. Fluor was detected in the Aragonite of Volterra, etc.

AUGITE, see *Pyroxene*.

AURICHALCITE [p. 460].—Loc. in Lancaster, Pa., W. J. Taylor, Am. J. Sci., xx, 412.

AZURITE [p. 459].—Analysis of Azurite from Phœnixville, Pa., J. L. Smith, Am. J. Sci., xx, 250.

BABINGTONITE [p. 178].—Babingtonite is brought by Dauber into close connection with the Paisbergite (Pogg., xciv, 402). From an examination of 82 crystals, he arrives at the angles ab=112° 12′, ac=92° 32′, bc=87° 24′. Referred to the form of Augite (see figure under Paisbergite) these angles are $O:I'$=112° 12′, $O:I$=92° 32′, $I:I'$=87° 24′. Cleavage parallel to c (I), less so parallel to b (I').

BARYTES [p. 366].—Crystallographic structure of crystals as ascertained by erosion with acid, Leydolt, Acad. Wiss. Wien, May, 1855.

BERYL [p. 178].—Many figures of Russian crystals by Kokscharov, Min. Russl., 1854, p. 147. One crystal affords the plane $12\frac{2}{11}$. Specific gravity of transparent crystals: from Mursinka, yellow, 2·694; ib. greenish-yellow, 2·683; ib. greenish-yellow, 2·681: from Schaitanka, colorless, 2·694, 2·695; pale rose-red, 2·725; apple-green, 2·710: from Adun-Tschilon, bluish-green, 2·677: from Urulga, green, 2·702. $O:1$=150° 3′ 24″.

The Emeral of the Ural afforded A. B. Kammerer, sp. gr. =2·710—2·759; 2·742, a mean of the best results.

BITUMEN [p. 469]—Locality in California, W. P. Blake, Am. J. Sci. [2], xix, 433, xx, 84.

Pitch lake of Trinidad, N. S. Manross, Am. J. Sci. [2], xx, 153.

BLENDE [p. 49].—Analysis; from Phœnixville, Pa., J. L. Smith, Am. J. Sci., xx, 250.

BORACITE [p. 393].—The massive boracite of Stassfurth, which occurs in large or small masses, of a pure snow-white color, dissolves easily in dilute muriatic, nitric, or sulphuric acid, and in concentrated hydrofluoric acid, without heat, unlike the Boracite of Lüneburg and Segeberg. When pulverized the particles show electric polarity like those of the crystallized Boracite, (G. H. O. Volger, Mon. d. Borazites, 1855, p. 68).

BRONGNIARDITE [p. 76].—Damour states (Ann. d. Mines [5], vi, 146) that a specimen of this mineral from Bolivia (the original locality) contains cavities in which it is crystallized in regular octahedrons with replaced edges. Damour observes that the species is thus related to Dufrenoysite, which has the same crystallization and a similar formula. The formula of Brongniardite is (Pb, Ag) $S+\frac{1}{2}\dot{S}b^2S^3$, and Dufrenoysite $PbS+\frac{1}{2}As^2S^3$.

BROOKITE [p. 123].—Sp. gr., according to Romanowsky, of transparent crystals from the Urals, 4·21–4·23; of untransparent, 4·15–4·16; of pulverized mineral, 4·20. Analysis $\dot{T}i$ 94·31, $\dot{F}e$ 3·28, ign. 1·31=98·90. (Kokscharov's Min. Russl., ii, 79.)

BRUCITE [p. 133].—Loc. in Russia, Kokscharov, Min. Russl., ii, 111.

BURATITE, see *Aurichalcite*.

BYTOWNITE [p. 237].—Note on Bytownite, by T. S. Hunt, Am. J. Sci. [2], **xix**, 429.

CALAMINE [p. 313].—Dauber (Pogg., xcii, 245) adds the planes $\frac{1}{2}$, $\frac{3}{2}$, $3\text{-}\frac{3}{2}$, $\frac{4}{3}\text{-}4$, from crystals from Altenberg; and gives for $O:1\text{-}\breve{\infty}=148°\ 34'$; $O:1\text{-}\breve{\infty}=154°\ 31'$.
Loc. at Phœnixville, Pa., J. L. Smith, Am. J. Sci. [2], **xx**, 250.

CALCITE [p. 435].—Singular crystallization of Calcite from Phœnixville, Pa., Am. J. Sci., **xx**, 251.
A new twin of Calcite, Kenngott, Min. Not., No. 17.
Calcite associated with the red zinc ore of New Jersey, gave Jenzsch (Pogg. xcvi, 147):

$\dot{C}a\,\breve{C}$	$\dot{M}g\,\breve{C}$	$\dot{M}n\,\breve{C}$	$\dot{F}e\,\breve{C}$	$\dot{Z}n\,\breve{C}$	Ca Fl	$\dot{H}$	$\breve{S}$	
79·96	1·94	11·09	0·60	0·58	5·35	0·32	*tr.*	=99·84

It is white, and has the Zinc ore and Franklinite disseminated through it. G.=2·788; or in grains, carefully separated from impurities, 2·810–2·817. Cleavage angle 104° 57½. Jenzsch has found fluor also in Calcite from Brientz, white cleavable from Freiberg (Himmelsfurst mine), Andreasberg (Abendrothe mine), Kupferberg in Silesia, Adelsberg cave, scalenohedrons from Junge Hohe Birke mine near Freiberg, white from Sala in Sweden, flesh-red from Arendal, wine-yellow from Sangerhausen.

CALOMEL [p. 89].—New planes on crystals from Moschellandsberg, observed by F. Hessenberg (Lieb. u. Kopp, 1854, 869), as follows, $\frac{1}{4}$, 2, $\infty\text{-}\frac{4}{3}$, $\frac{4}{5}\text{-}2$, 2-2, $2\text{-}\frac{3}{2}$. $O:1\text{-}\infty\ (1\dot{i})=129°\ 40'$; $O:2\text{-}\infty\ (2\dot{i})=112°\ 35'$.—[In the Mineralogy, $O:1\dot{i}=112°\ 5'$ should read $O:2\dot{i}=112°\ 5'$.—D.]

CANCRINITE [p. 233].—Analysis of the Cancrinite of Miask (Kokscharov's Min. Russl., ii, 77):

$\breve{S}i$	$\dot{A}l$	$\dot{C}a$	$\dot{N}a$ (*tr.* of $\dot{K}$)	$\breve{C}$	$\dot{H}$	
35·50*	28·16	6·16	20·20	5·83	3·80	=99·65.

CLINOCHLORE [p. 293].—The clinochlore of Pennsylvania has been examined carefully by M. Senarmont (Ann. d. Mines, [5], vi, 568), who confirms the results of Mr. Blake. On examining a hexagonal crystalline plate, the plane of the optic axes was found to be parallel to one side of the hexagon, and consequently to the principal section of the oblique prism. The two optical axes, which are very divergent, have this divergence increased by heat, and the inclination to the plane of cleavage: moreover the system of rings the most inclined to this plane passes out of the field of the microscope, while the other remains sensibly immoveable. The "clinochlore" of Achmatowsk and Schwarzenstein do not act at all like that of Pennsylvania: an oval system of rings is seen elongated in the direction of the shorter diagonal, and hence the two optic axes are but little inclined to one another; the divergence, if there be any, is too slight to be determined; moreover heat has no effect on it.
The Pennine of Zermatt and Ala acts in general like crystals of the hexagonal system.
On Clinochlore of Achmatowsk in the Urals, Kokscharov, Min. Russl., ii, 7, and Am. J. Sci., [2], xix, 176.

CERUSITE [p. 452].—Loc. Phœnixville, Pa., J. L. Smith, Am. J. Sci., xx, 245.

CHABAZITE [p. 319].—*Glottalite* has been referred to Chabazite by R. P. Greg, Jr., Phil. Mag. [4], x, 118.

CHALCOPYRITE [p. 68].—Analysis; from Phœnixville, Pa., J. L. Smith, Am. J. Sci., [2], xx, 249.—Loc. in California, Am. J. Sci. [2], xx, 81.

CHONDRODITE [p. 186].—Transparent crystals of Chondrodite from limestone at Pargas have been measured by N. A. E. Nordenskiöld (Pogg., xcvi, 118). The form is a right prism but hemihedral so as to have a monoclinic aspect, as with the chondrodite of Orange Co. The planes given for the common form are I, $i\bar{1}$, $\breve{i}\bar{1}$, $\frac{1}{3}\bar{1}$, $1\bar{1}$, $\frac{5}{3}\frac{5}{4}$, $1\frac{3}{4}$; $I : I = 114° 37'$, $\breve{i}\bar{1} : 1\bar{1} = 136° 1'$, $\breve{i}\bar{1} : \frac{1}{3}\bar{1} = 109° 3'$, $I : \frac{5}{3}\frac{5}{4} = 159° 14'$, $I : 1\frac{3}{4} = 156° 17'$.

The axes, a (vertical): $b : c = 1{\cdot}0361 : 1 : 0{\cdot}6417$.

[The author cites the figure by the writer as given in the third edition of his mineralogy, but has not seen his later views in his fourth edition, and in this Journal, vol. xiv, p. 175, 1852. By changing the position of the crystal, making c the vertical axis, it then corresponds very closely with Scacchi's second type of Humite. The lettering of the crystal above given, I, $i\bar{1}$, $\breve{i}\bar{1}$, $\frac{1}{3}\bar{1}$, $1\bar{1}$, becomes (see Min., p. 187), $1\bar{1}$, $\breve{i}\bar{1}$, O, $2\bar{1}$, $\frac{2}{3}\bar{1}$.

Chondrodite, Nordenskiöld.	Humite, Type II, Scacchi.
$1\bar{1} : 1\bar{1} = 114° 37'$	$115° 6'$
$O : 2\bar{1} = 136° 1'$	$135° 52\frac{1}{2}'$
$O : \frac{2}{3}\bar{1} = 109° 3'$	$108° 58'$

These angles fix the dimensions of the crystals. The agreement is much nearer than between either two of the three types of Humite.—J. D. D.]

CHROMIC IRON [p. 106].—Loc. in California, Am. J. Sci., [2], xx, 82.

CHRYSOCOLLA [p. 309].—Analysis of a Chilian specimen by J. L. Smith (Gilliss's Exped., ii, 92): $\ddot{S}i$ 31·35, $\ddot{C}u$ 42·51, $\dot{H}$ 21·62, $\ddot{F}e$ 1·97, $\ddot{A}l$ 2·83=100·28; formula nearly $\ddot{C}u^3\ddot{S}i^2+6\dot{H}$.

CHRYSOLITE [p. 184].—Analysis of a wine-yellow chrysolite from the Eiffel by Th. Kjerulf (Nyt. Mag., viii, 173, and J. f. pr. Chem., lxv, 187):

$\ddot{S}i$ 42·21, $\dot{M}g$ 49·29, $\ddot{F}e$ 8·91, $\ddot{A}l$ 0·18 $\ddot{C}r$ 0·004, ign. 0·12=100·72.

CINNABAR [p. 48].—Mine in California, Am. J. Sci. [2], xx, 80.

COAL [p. 26].—Analysis of mineral charcoal, by T. H. Rowney, (Edinb. N. Phil. J. [2], ii, 141 (each a mean of two analyses):

	C	H	N	O	Ash.
1. Glasgow coal fields,	82·97	3·35	0·75	6·85	6·08 = 100
2. Stonelaws coal,	72·74	2·35	5·83		19·08 = 100
2. Ayrshire coal,	73·42	2·94	8·25		15·39 = 100
9. Fifeshire, Splint coal,	74·72	2·74	7·67		14·87 = 100
4. " "	81·17	3·85		14·98	= 100

The hard coals associated with the last two charcoals consist of

	C	H	S	N	O	Ash
1.	80·63	5·16	0·84	1·33	10·61	1·43
2.	80·93	5·21	0·63	1·57	10·91	0·75

The charcoals differ from the hard coals but slightly in composition, and Mr. Rowney prefers the name *Fibrous Anthracite*, used by Prof. Bischoff, to that of Mineral charcoal.

COLUMBITE [p. 353].—The metallic acids of the Columbite of Middletown, according to Hermann (J. f. pr. Chem., lxv, 74), consist, in 100 parts, of Columbic (niobic) acid 58·44 parts, Ilmenous acid $\ddot{I}l^2O^3$ 18·26, Ilmenic acid $\ddot{I}l$ 23·30. The whole composition according to Hermann is—

$\dddot{W}$	$\ddot{C}o$	$\dddot{I}l$	$\ddot{I}l$	$\ddot{S}n$	$\ddot{F}e$	$\dot{M}n$	$\dot{M}g$
0·26	45·71	14·28	18·23	0·40	14·06	5·63	0·49 = 99·06

and affords him the formula $3\ddot{R}(\ddot{C}o, \dddot{I}l)+2\ddot{R}\ddot{I}l$.

The atomic weight of Ilmenium is stated to be 2042·0, and that of Columbium (niobium) 2230·14.

The Columbite of Bodenmais affords:

$\dot{\mathrm{C}}o$	$\dot{\mathrm{C}}o$	$\dot{\mathrm{S}}n$	$\dot{\mathrm{F}}e$	$\dot{\mathrm{M}}n$	$\dot{\mathrm{C}}u$
45·40	35·67	0·45	14·30	3·85	0·13 = 99·80

Formula deduced $\dot{R}\,\dot{C}o^3 + 3\dot{R}\,\dot{C}o$.

Samarskite has the formula $3\dot{R}^2\,\ddot{\underline{I}}l + 4\dot{R}^2\,\ddot{I}l$, consisting of—

$\underline{\dot{I}}l$	$\dot{I}l$	$\dot{M}g$	$\dot{M}n$	$\dot{F}e$	$\dot{U}$	$\dot{Y}$	$\dot{C}e$, $\dot{L}a$	ign.
33·25	23·11	0·50	1·20	8·87	16·63	13·29	2·85	0·33 = 100·03

Æschynite has the formula $2\dot{R}\,\dot{I}l + \dot{C}e\,\dot{T}i^3$, containing

$\dot{I}l$	$\dot{T}i$	$\dot{C}e$	$\dot{C}e$	$\dot{L}a$	$\dot{Y}$	$\dot{F}e$	ign.
33·20	25·90	22·20	5·12	6·22	1·28	5·45	1·20 = 100·57

Yttroilmenite contains $\dot{I}l$ and $\underline{\dot{I}}l$ 57·81, $\dot{T}i$ 5·90, $\dot{Y}$ 18·30, $\dot{F}e$ 13·61, $\dot{M}n$ 0·31, $\dot{C}a$ 0·50, $\dot{U}$ 1·87, $\dot{C}e$ and $\dot{L}a$ 2·27 = 100·57.

Pyrochlore (the Fluopyrochlore of Miask) contains $\underline{\dot{I}}l$ 46·25, $\dot{I}l$ 14·58, $\dot{T}i$ 4·90 $\dot{C}e$, $\dot{L}a$ 15·23, $\dot{Y}$ 0·94, $\dot{F}e$ 2·23, $\dot{C}a$ 9·80, $\dot{M}g$ 1·46, K 0·54, Na 2·69, Fl 2·21 = 100·83, corresponding to $\dot{R}\,\underline{\dot{I}}l + \dot{R}^2\,(\dot{I}l, \dot{T}i) + 2{\cdot}21$ p. c. Fl. [The existence of Ilmenium is yet in dispute.]

Copper and Copper Ores.—In California, Am. J. Sci. [2], xx, 81.—Chili, J. L. Smith, Gilliss's Exped. ii, 88.

Corundum [p. 111.]—$O : 1$, according to measurement by Kokscharov, equals 122° 25′ (Min. Russl., ii, 80).

Cryolite [p. 97].—M. Leydolt has investigated the molecular structure of crystals of anhydrite and cryolite, and he shows that cryolite is identical with anhydrite in form, cleavage, color, lustre, hardness and specific gravity, and differs only in the facility of cleavage and in chemical composition.—Akad. Wiss., Wien, April, 1855.

Danburite [p. 212].—The analyses of Danburite, by Smith and Brush (this Journal, xvi, 365,) are questioned without good reason by Kenngott in his Min. Forsch. for 1853, p. 106.

Datholite [p. 334].—The crystallization of Datholite has been carefully studied by F. H. Schröder, in order to ascertain whether the prism is right as stated by Brooke and Miller and Hess, or oblique. He makes it slightly oblique, though still leaving it in doubt, the inclination obtained being 90° 6′; he gives $O : 2i$ [see Min., p. 334] = 135° 11′, $O : 1$ = 153° 34′.—Pogg. Ann., xciv, 235.

Dolomite [p. 441].—Coral rock of Matea afforded T. S. Hunt, $\dot{C}a\,\ddot{C}$ 60·50, $\dot{M}g\,\ddot{C}$ 38·77, $\ddot{S}i$, etc., 0·30 = 99·57.—Am. J. Sci., [2], xix, 429.

Analyses of compact magnesian limestone of Missouri, by Dr. Litton (Rep. Geol. Missouri, 1855):

	$\dot{C}a\,\ddot{C}$	$\dot{M}g\,\ddot{C}$	$\dot{A}l, \dot{F}e$	Insol. or $\ddot{S}i$
1. Chouteau Springs,	48·23	34·93	2·01	13·90 = 99·07
2. Atkisson's Well,	47·01	38·86	0·52	13·27 = 99·66
3. Cotton Rock,	50·80	40·56	1·07	6·21, $\dot{H}$ 0·21 = 98·85
4. From Coal Measures,	61·18	25·70	9·00	3·04 = 98·92

The same report contains analyses also of Missouri limestones not magnesian.

Dufrenoysite [p. 77].—J. C. Heusser observes in Pogg., xciv, 334, that the mineral named *Scleroclase* by von Waltershausen [see preceding Suppl., this Journ., vol. xix, p. 355], should retain the name *Dufrenoysite*, given it by Damour, and that the species called *Arsenomelan* by him, has for some time borne the name *Binnite*, being so called in Krantz's Catalogue.

Epidote [p. 206].—Analysis by Scheerer (Pogg., xcv, 501):

	$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{H}$		
1. Guttanen,	38·05	26·39	9·72	23·54	2·02 =	99·72	G.=3·373
2. Sustenhorn, *gnh-bn*,	38·43	26·18	8·77	24·13	2·46 =	99·97	G.=3·326
3. Lole, *gnh-bn*,	38·39	28·48	7·56	22·64	2·30 =	99·37	G.=3·359
4. Gotthard, (*Escherite*),	38·08	27·74	8·26	23·53	2·04 =	99·65	G.=3·384
5. Kaverdiras, *bnh-gn*,	37·66	27·35	8·89	23·91	2·33 =	100·14	G.=3·369
6. Gotthard, *bnh-gn*,	38·28	27·52	8·66	22·87	2·41 =	99·74	G.=3·378
7. Bourg d'Oisans,	37·35	22·02	15·67	22·54	2·35 =	99·93	

These analyses give Scheerer for the mean oxygen ratio, for

$$\dot{H}, \dot{R}, \ddot{R}, \breve{S}i, \quad 2{\cdot}02 : 6{\cdot}66 : 15{\cdot}28 : 19{\cdot}73.$$

Scheerer, in accordance with his hypothesis, supposes $3\ddot{R}$ to replace $2\breve{S}i$, and $3\dot{H}$ replace $1\dot{R}$, and thus arrives at the ratio for $[\breve{S}i] : (\ddot{R})$, of 4 : 1. The oxygen ratio for $\breve{A}l$ and $\ddot{F}e$ in the epidote of Bourg d'Oisans, Arendal and Traversella is 2 : 1; in that of Guttanen, 4 : 1; that of Kaverdiras, 5 : 1; that of Lole, 6 : 1.

The Zoisite of the Saualpe in Carinthia, where it occurs in gneiss, contains zirconia according to an analysis by Kuleszna, in which he obtained—

$\breve{S}i$ 44·00, $\breve{A}l$ 30·97, $\dot{C}a$ 17·76, $\ddot{F}e$ 4·92, $\breve{Z}r$ 2·00 = 99·67.

The author observes that Klaproth's analyses are erroneous.

Euclase [p. 267].—Mean of four analyses by M. A. Damour (Comptes Rend., xl, 944):

	$\breve{S}i$	$\breve{A}l$	$\breve{B}e$	$\dot{C}a$	$\dot{F}e$	$\breve{S}n$	$\dot{H}$	Fl
	41·63	34·07	16·97	0·14	1·03	0·34	6·04	0·38=100·60
Oxygen,	21·61	15·92	10·73				5·37	

[The oxygen ratio between the bases and the silica is between 5 : 4 and 4 : 3. With the latter, the formula is $(\frac{2}{5}\breve{B}e + \frac{3}{5}\breve{A}l)\,\breve{S}i^{\frac{4}{3}} + \frac{1}{5}\dot{H}$, or $2\breve{B}e\breve{S}i^{\frac{4}{3}} + 3\breve{A}l\,\breve{S}i^{\frac{4}{3}} + \dot{H}$, differing from the analyses of Mallet and Berzelius in containing the $\breve{B}e$ and $\breve{A}l$ in the ratio of 2 to 3 instead of 1 : 1, and also in the water as well as fluorine.—D.]

EUKAMPTITE, *Kenngott* (Min. Forsch. for 1853, 58).—Thin foliated or micaceous and resembling chlorite, occurring in granite near Pressburg, Hungary. Very thin plates brown to hyacinth-red or reddish-yellow. Streak grayish-green to brownish-green. G.=2·73. H. a little above 2. Not magnetic. In the flame of a spirit lamp, becomes pinchbeck-brown, to white, semi-metallic and opaque. In a tube exfoliates and yields water. BB. blackens; thin leaves fuse on the edges to a magnetic globule. With borax fuses easily; with salt of phosphorus difficultly, yielding a silica skeleton; with soda swells up and shows a manganese reaction. Analysis by v. Hauer:

$\breve{S}i$	$\breve{A}l$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{H}$
38·13	21·60	19·92	2·61	13·76	3·98=100.

Oxygen ratio for $\dot{R}, \ddot{R}, \breve{S}i, \dot{H}$, $3 : 3 : 6 : 1 = 1 : 1 : 2 : \frac{1}{3}$.

The name alludes to the softness and flexibility of the mineral.

[Excluding the water, the composition conforms to the general formula of Biotite $(\frac{1}{4}\dot{R}^3 + \frac{1}{4}\ddot{R})\,\breve{S}i$, or $\dot{R}^3\,\breve{S}i + \ddot{R}\,\breve{S}i$.—J. D. D.]

ENSTATITE, *Kenngott* (Min. Not., No. 17).—Augitic in crystallization, although having some resemblance to Scapolite. $I : I = 87°$. Cleavage parallel to I distinct, and having a pearly lustre. Color grayish or yellowish-white. H.=5·5. G.=3·10–3·13. BB. infusible, and to this the name alludes. No action with muriatic acid. According to von Hauer contains, $\breve{S}i$ 56·91, $\breve{A}l$ 2·50, $\dot{F}e$ 2·76, $\dot{M}g$ 35·44, $\dot{H}$ 1·92 (0·41 lost at 100° C.); and hence it is a bisilicate of Magnesia ($\dot{M}g^3\breve{S}i^2$), as Wollastonite is a bisilicate of lime ($\dot{C}a^3\breve{S}i^2$).

The augite group hence includes

Wollastonite	$\dot{C}a^3\,\breve{S}i^2$,	Diopside	$(\dot{C}a, \dot{M}g)^3\,\breve{S}i^2$,
Enstatite	$\dot{M}g^3\,\breve{S}i^2$,	Hedenbergite	$(\dot{C}a, \dot{F}e)^3\,\breve{S}i^2$,
Grunerite	$\dot{F}e^3\,\breve{S}i^2$,	Bustamite	$(\dot{C}a, \dot{M}n)^3\,\breve{S}i^2$,
Rhodonite	$\dot{M}n^3\,\breve{S}i^2$,	Hypersthene	$(\dot{F}e, \dot{M}n)^3\,\breve{S}i^2$,

besides other related compounds, included under pyroxene.

Feldspar [p. 234 to 242].—On some feldspathic minerals from the Hypersthene rock of Canada, by T. S. Hunt, Phil. Mag., [4], ix, 354. The paper contains the following analyses, besides others contributed to the Mineralogy:

		Si	Al	Fe	Ca	Mg	Na	K	ign.
1.	*Andesine,*	59·55	25·62	0·75	7·73	*tr.*	5·09	0·96	0·45=100·15
2.	"	59·85	25·55	0·65	6·94	0·11			0·30
3.	"	58·50	25·80	1·00	8·06	0·20	5·45	1·16	0·40=100·57
4.		55·80	26·90	1·53	9·01	0·27	4·77	0·86	0·45= 99·59
5.		57·20	26·40	0·40	8·34	——	5·83	0·84	0·65= 99·66
6.		57·55	27·10		8·73	——	5·38	0·79	0·20= 99·75
7.		54·45	28·05	0·45	9·68	——	6·25	1·06	0·55=100·49
8.		58·15	26·09	0·50	7·78	0·16	5·55	1·21	0·45= 99·89

1, 2, color flesh-red, reddish, greenish and grayish-brown, G.=2·667−2·674; 3, granular greenish base of same rock, G.=2·665−2·668; 4, pale greenish and bluish-gray, finely granular, G. of greenish-gray portion, 2·681; 5, 6, color pale lavender-blue, G.=2·680−2·692; numbers 1 to 6 from Chateau Richer;—7, from district of Montreal, bluish, G.=2·691; 8, from La Chute, associated like the above with crystalline limestone, color lavender-blue, G.=2·687.

Mr. Hunt supposes that albite and anorthite are the only two distinct species of triclinic feldspar, and that others, intermediate in composition, are mixtures of these two homœomorphous species.

On the composition of some Feldspars (*Orthoclase*) of the granite of the Dublin and Wicklow mountains, J. A. Galbraith, Phil. Mag., [4], ix, 40 (anal. 1—7), and **x**, 115 (anal. 8):

	Si	Al	Mg	Ca	K	Na	ign.	
1. Dalkey, Co. Dublin,	64·00	18·11	0·57	*tr.*	12·73	3·00	0·55= 98·96;	G.=2·540
2. Three Rock Mountain,	65·40	17·71	1·77	*tr.*	10·68	3·26	0·69= 99·51;	G.=2·562
3. L. Bray,	65·44	18·36	——	0·80	12·34	2·73	0·52=100·19;	G.=2·554
4. L. Dan, Co. Wicklow,	65·05	17·72	*tr.*	0·23	13·42	2·75	0·36= 99·53;	G.=2·559
5. Glenmacanass, "	64·19	18·39	0·34	0·70	11·39	2·95	0·58= 98·54;	G.=2·553
6. Glendalough, "	63·60	18·84	0·40	*tr.*	14·33	1·92	0·60= 99·69;	G.=2·453
7. Glenmalur, Co. Dublin,	64·48	19·04	1·02	*tr.*	10·74	2·64	0·78= 98·70;	G.=2·560
8. Near Dublin,	70·32	16·12	Fe 3·20	1·34	4·65	3·39	0·96= 99·98	

A variety of *Orthoclase* containing lithia, from the vicinity of Radeberg, afforded G. Jenzsch (Pogg., xcv, 304):

	Si	Al	Mg	Li	Na	K	Fl and B (ign.)
	65·24	20·40	0·84	0·71	0·27	12·35	0·52 = 100·33
Oxygen,	33·87	9·53	0·34	0·39	0·07	2·10	

G.=2·548. H.=6. Color smalt-blue to milk-white. Associated with lithia mica.

Pseudomorph of potash mica (muscovite) after feldspar, from the granite of Hirschberg. Analysis by Kjerulf (J. f. pr. Chem., lxv, 190):—

	Si	Al	Fe	Mg	K	Na	F
1. Orthoclase,	70·82	17·37	0·66	0·35	8·89	1·91	—— = 100
2. Mica pseud.,	51·73	28·75	5·37	0·62	8·28	2·14	0·83 = 97·83

The orthoclase analyzed may not have been quite pure, as it was selected in grains from the mica scales.

Analysis of *Labradorite*, (1) from a Hypersthene rock of Silesia, (2) from Gabbro, by G. von Rath (Pogg., xcv, 538—see Hypersthene, under *Pyroxene*):

	Si	Al	Fe	Ca	Mg	K	Na	ign.
1.	52·25	28·32	2·44	11·61	0·48	0·64	4·52	0·62 = 101·18
Oxygen,	27·29	13·24	0·72	3·30	0·19	0·11	1·16	
2.	50·31	27·31	1·71	10·57	0·78	1·55	4·81	2·20 = 99·24
Oxygen,	26·14	12·75	0·51	3·01	0·31	0·26	1·23	

Color bluish-gray, without opalescence. For 1, G. = 2·715; for 2, G. = 2·707.

Labradorite occurs in the Witchita Mts., west of the Mississippi, (Marcy's Rep. Expl. Red River, p. 137.)

Deville regards *Vosgite* as an altered *Labradorite*. (Ann. Ch. Phys. [3], xl, 271). He has analyzed the mineral from Ternuay, and obtained:

	$\dot{S}i$	$\dot{A}l$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	ign
1.	59·07	26·67	7·96	0·58	4·95	*tr.*	0·77 = 100
2.	57·01	28·05	7·53	0·39	5·47	0·12	1·43 = 100
3.	52·40	24·78	15·02	0·51	5·10	0·14	2·05 = 100

No. 1 is analysis of the whole crystal; No. 2 of the inner portion; No. 3 of the outer; the last afforded 2·6 p. c. of carbonate of lime. Oxygen ratio for $\dot{R}$, $\ddot{R}$, $\ddot{S}i$ of No. 1, 0·90 : 3 : 7·43; of No. 2, 0·84 : 3 : 6·78; and of 3, 1·41 : 3 : 7·05.

Andesine, according to Deville (Ann. Ch. Phys., [3], xl, 283), is altered oligoclase. Specimens of the porphyry of Marmato afford 3·5 to 5 p. c. of carbonate of lime. Three trials gave—

	$\ddot{S}i$	$\ddot{A}l$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	ign	
1.	63·85	24·05	5·04	0·38	5·04	0·88	0·76 = 100;	G = 2·61
2.	60·69	26·04	3·89	0·85	5·32	1·01	2·20 = 100;	G = 2·62
3.	58·11	28·16	5·35	1·52	5·17	0·44	1·25 = 100	

No. 1 gives Deville for the oxygen ratio for $\dot{R}$ $\ddot{R}$, $\ddot{S}i$, 0·96 : 3 : 8·86; No. 2, 0·72 : 3 : 7·78; No. 3, 0·79 : 3 : 6·89. No. 1 appeared unaltered; No. 2 afforded 1·4 p. c. of carbonate of lime. Deville refers here also the Ryakolite (?) of Teneriffe.

Analysis of *Labradorite* from Sweden (from the north slope of the Linderöds Mts.), sp. gr. 2·68, by Blomstrand (Oefv. Ak. Förh., 1854, p. 296.):

$\ddot{S}i$	$\ddot{A}l$	$\ddot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$
53·82	26·96	1·43	11·20	0·20	1·34	5·00 = 99·95

FELSOBANYITE [Suppl. I]. Found at Kapnik in Hungary.

FLUOR [p. 94].—Kenngott (Min. Not., No. 14) describes a green trisoctahedron of fluor which has very narrow dodecahedral planes of a violet-blue color. It has some resemblance to a crystal from Saxony in which the three axial sections were colorless, while the rest of the crystal was violet-blue.

He describes and figures an octahedral crystal of the same species, from Schlackenwald, which has a small dodecahedron of fluor on each angle. The color is pale violet-blue.

Still another form he mentions, which is a peculiar twin presenting faces of the cube and the tetrahexahedron $\infty O3$. Small globular concretions violet-blue to colorless, have been found at Kapnik.

For fluor in *Aragonite* and *Calcite*, see those species.

GALACTITE [1st Suppl.]—Kenngott states from Haidinger, that Galactite occurs white, and that the locality is Glenfarg in Perthshire, Scotland.

GALENA [p. 39].—The Galena of Missouri afforded Dr. Litton usually a trace of silver—the highest per-centage ·0027. Mine La Motte Galena gave ·0012 to ·0027, Rep. Geol. Missouri, 1855, in which there are notices of the various mines of the state.

Galena at Phenixville, Pa., Smith, Am. J. Sci., xx, 248.

GARNET [p. 190].—A black Garnet occurring with green feldspar in Norway, contains yttria; analysis by Prof. Bergemann (Sitz. nied. Ges., Bonn, July, 1854):

$\dot{B}i$	$\dot{F}e$	$\dot{C}a$	$\dot{M}n$	$\dot{M}g$	$\dot{Y}$	$\ddot{A}l$
34·94	30·01	26·04	1·09	0·50	6·66	*tr.*

Specific gravity 3·88. H. = 5, or like apatite.

GLAUBER SALT [p. 386].—Analysis of the Salt from Guipuscoa, Spain, by Rivot (Ann. d. Mines, [5], vi, 558):

$\ddot{S}$	$\dot{N}a$	$\dot{K}$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$
24·8	19·5	*tr.*	0·3	0·5	54·5

It corresponds to the formula $\dot{N}a\ddot{S}+10\dot{H}$. Occurs in a thick bed, and is compact, massive, of a white color. Effloresces rapidly.

GLAUCONITE OR GREEN SAND [p. 288].—Composition of the Green Sand of Essen in Rhenish Westphalia, according to D. H. von Dechen (Verh. nat. Ver., Bonn, 1855, 176):

$\ddot{S}i$ 58·17 $\ddot{A}l$ 10·09 $\ddot{F}e$ 18·75 $\dot{M}g$ 3·37 $\dot{K}$ 3·37 $\dot{H}$ 6·25 = 100

These green grains make up 33·1 p. c. of the sand; of the rest 41 p. c. are quartz sand, and 2·59 p. c. are a calcareous cement, consisting of

$\dot{C}a\dot{C}$ 78·1 $\dot{M}g\dot{C}$ 1·6 $\dot{C}a^3\dot{P}$ 10·3 $\ddot{A}l$ 6·4 $\ddot{F}e$ 3·6 F *tr.* = 100

GLOTTALITE [p. 319].—See *Chabazite.*

GOLD [p. 7].—W. P. Blake on the California mines, Am. J. Sci. [2], xx, 72.

GOLD AMALGAM [p. 15]—Found at Mariposa, California. Analysis by F. Sonnenschein (Zeitsch. d. deutsch geol. Gesellsch., vi, 243, in Lieb. u. Kopp., 1854, p. 807). Gold 39·02 and 41·63, with quicksilver 60·98 and 58·37. Color yellowish-white. In 4-sided prisms. M. Schmitz is stated to be authority for this locality.

GRAPHITE [p. 29].—According to Kenngott (Min. Not., No. 14), a specimen of a graphite from Ticonderoga, contains crystals in hexagonal tables, having the planes of two pyramids on the basal edges, and of a rhombohedron on the angles. Angle between the base (*O*) of the prism and one pyramid, 110°, between *O* and the other pyramid, 137°; *O* and the rhombohedron, 122°. The last gives by calculation for $\dot{R}:R$=85° 30′, or exactly 85° 29′. Calling this the fundamental rhombohedron, *R*, the pyramids are 2P2 and $\frac{1}{2}$P2. Haidinger, in his Handb. der bestim. Min., p. 513, mentions a pyramid having for the angle at the side edge 40° 56′. It is probably $\frac{1}{4}$R, in which this angle would be 38° 13′. If the pyramid belongs to the same zone with 2P2, it may be $\frac{1}{2}$P2, which affords the side angle 43° 37′. Specific gravity of the Ticonderoga graphite, 2·229.

Crystals of graphite from Ersby and Storgard have been studied by N. A. E. Nordenskiöld (Pogg., xcvi, 110) and pronounced monoclinic; the form a short 6-sided oblique table much like common mica. *ii* (cleavage face) on faces of an oblique prism c''=106° 21, $c'':c''$=122° 24′. Inclination of the vertical axis 88° 14′.

GYPSUM [p. 377].—Abundant west of Mississippi, Marcy's Rep. Expl. Red River, p. 148, 164, &c. In California, Am. J. Sci., [2], xx, 83.

HAUSMANNITE [p. 118].—A form of compound crystal of Hausmannite similar in general character to figure 295A, Min., p. 69, has been observed by Kenngott (Min. Not., No. 16). It presents the octahedral planes 1, and on the angles, 4 planes, $\frac{1}{3}$.

Dauber (Pogg., xciv, 406) has obtained for the pyramidal angle of 1, 105° 50′; and for $\frac{1}{3}$, 140′ 31, from the Hausmannite of Ilmenau.

HEMATITE (Specular Iron) [p. 113].—Octahedrons, pseudomorph after magnetite, Nöggerath (Sitz. nied. Ges., Bonn, July, 1854).—On ore of Missouri, Geol. Report by G. C. Swallow, 1855.

HERRERITE [1st Suppl.]—Identity with Smithsonite, Am. J. Sci., xx, 118.

HEDDLITE, *Greg.*—A native oxalate of potash, according to M. Forster Heddle; color-purplish red, arising from some oxalate of cobalt. From a copper mine at the Old Man, near Coniston Lake in Westmoreland, England, associated with Conistonite of Greg. Edinb. N. Phil. J., [2], i, 365.

HIRCINE, *Piddington.*—A fossil resin supposed to be new. Arch. d. Pharm., lxxiv, 318, and Kenngott's Min. Forsch for 1853, p. 134.

HORNBLENDE [p. 170].—The greenstone of Neurode in Silesia consists of Saussurite (Labradorite) 43½ p. c., and a hornblende having the composition of augite, and therefore uralite (56½ p. c.). Part of the hornblende shows evidence of alteration. G.=3·273. Analysis by von Rath (Pogg., xcv, 557):

$\ddot{S}i$ 48·70 $\ddot{A}l$ 0·82 $\dot{F}e$ 25·21 $\dot{C}a$ 11·25 $\dot{M}g$ 12·01 alkalies *tr.* ign. 1·01=99·00

affording the oxygen ratio for $\dot{R}$, $\ddot{R}$, $\ddot{S}i$, 13·60 : 0·38 : 25·30.

A hornblende-like mineral, a constituent of the Zircon-Syenite of Norway, afforded von Kovanko the following composition—except that the iron, in accordance with a subsequent examination by v. Puzyrewsky, is made part peroxyd, (Th. Scheerer in J. f. pr. Chem., lxv, 341):

	$\ddot{S}i$	$\ddot{A}l$	$\ddot{F}e$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	$\dot{H}$
	37·34	12·66	10·24	9·02	0·75	11·43	10·35	4·18	2·11	1·85=99·93
Oxygen	19·38	5·91	3·07	2·00	0·17	3·27	4·14	1·08	0·36	1·64

Oxygen ratio for $\dot{H}$, $\dot{R}$, $\ddot{R}$, $\ddot{S}i$, 1·64 : 11·02 : 8·98 : 19·38.

Scheerer by his theory (taking $3\dot{R}=2\ddot{S}i$, and $3\dot{H}=1\dot{M}g$) makes out the formula $(\dot{R})[\ddot{S}i]+(\dot{R})^2[\ddot{S}i]^2$, the hornblende formula.

[The composition obtained is near that of Epidote; the propriety of calling the species hornblende may be questioned.—J. D. D.]

NORDENSKIÖLDITE is identical with Tremolite, (Kenngott, Sitz. Wien, xii, 297.)

HYPERSTHENE, see *Pyroxene*.

IDOCRASE [p. 197].—Analyses and descriptions by Rammelsberg (Pogg. xciv, 92)—the results here cited, mean of 2 or 3 analyses—

	$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$		
1. Vesuvius, *yvh-bn*,	37·75	17·23	4·43	37·35	3·79	—	=100·55	G.=3·382
2. " *dull bn*,	37·83	10·98	9·03	35·69	4·37	—	= 97·90	G.=3·428–3·429
3 Monzoni, *yvh*,	38·25	15·49	2·16	36·70	4·31	0·47	= 97·38	G.=3·344
4. " *brown*,	37·56	11·61	7·29	36·45	5·33	—	= 98·24	G.=3.385
5. Dognazka,	37·15	15·52	4·85	36·77	5·42	0·35	=100·06	G.=3·378
6. Haslau, near Eger,	39·52	13·31	8·04	35·02	1·54	1·32	= 98·75	G.=3·411
7. Egg near Christiansand,	37·20	13·30	8·42	34·48	4·22	0·31	$\dot{T}i$ 1·51=99·44	G.=3·436
8. Eger,	37·88	14·48	7·45	34·28	4·30	—	$\dot{F}e$ 0·45=98·89	G.=3·384
9. Sanford, Me.,	37·64	15·64	6·07	35·86	2·06	—	$\dot{T}i$ 2·40=99·67	G.=3·434
10. Wilui,	38·40	10·51	7·15	35·96	7·70	—	= 99·72	G.=3·415
11. Ala,	37·15	13·44	6·47	37·41	2·87	0·93	= 98·27	G.=3·407

The oxygen ratios afforded for the $\dot{R}$, $\ddot{R}$, $\ddot{S}i$, are given by Rammelsberg as follows. (1) 1·3 : 1 : 2·1; (2) 1·5 : 1 : 2·5; (3) 1·5 : 1 : 2·5; (4) 1·6 : 1 : 2·5; (5) 1·5 : 1 : 2·2; (6) 1·3 : 1 : 2·4; (7) 1·4 : 1 : 2·4; (8) 1·3 : 1 : 2·2; (9) 1·3 : 1 : 2·3; (10) 1·9 : 1 : 2·8; (11) 1·5 : 1 : 2·3. Whence he deduces that 1·5 : 1 : 2·5 is the true ratio, [or adding the protoxyds and peroxyds 2·5 : 2·5=1 : 1]. Rammelsberg also shows that by regarding the iron as oxyd or partly so, the analyses of Magnus and Varrentrapp afford the same ratio nearly. Formula hence deduced, $3\dot{R}^3\ddot{S}i+2\ddot{R}\,\ddot{S}i$.

Analysis by J. W. Mallet (Am. J. Sci., [2], xx, 85):

$\ddot{S}i$ 38·32 $\ddot{A}l$ 25·68 $\dot{F}e$ 8·13 $\dot{C}a$ 25·29 $\dot{M}g$ 0·39 Cop. pyrites 1·91 = 99·79

The copper may possibly be present as oxyd instead of sulphuret. Loc. Ducktown, Tennessee. G.=3·359. Form of crystals *O*, 1, *I*, 1*i*, *ii*. Nearly colorless.

Scheerer has also analyzed different Idocrases, as follows (Pogg. xcv, 520):

	$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$	H Cl	
1. Ala,	37·35	11·85	9·23	*tr.*	32·70	6·03	2·73	0·015	= 99·90
2. Vesuvius,	37·80	12·11	9·36	*tr.*	32·11	7·11	1·67	undet.	=100·16
3. Eger, *bnh-gn*,	37·73	13·49	5·95	0·47	37·49	1·98	1·89	undet.	$\dot{F}e$ 0·95= 99·95

Mean oxygen ratio, for $\dot{H}$, $\dot{R}$, $\ddot{R}$, $\ddot{S}i$, is 1·86 : 11·86 : 8·28 : 19·53. [Excluding the water, the oxygen ratio for $\dot{R}+\ddot{R}$ and $\ddot{S}i$ is very nearly 1 : 1. Taking 566·25 as the equivalent of Silica, the ratio becomes 1·86 : 11·86 : 8·28 : 19·93, which is still nearer 1 : 1.—J. D. D.].

Scheerer makes out, by his polymerous isomorphism the augitic formula $(\dot{R})^3[\ddot{S}i]^2$.

The percentage of water in Idocrase has been determined as follows by G. Magnus (Pogg., xcvi, 347):—

	Water.	$\dot{C}$			Water.	$\dot{C}$
1. Slatoust,	2·44	0·15	3. Vesuvius, green,		0·29	undet.
2. Ala,	2·98	undet.	4. "	brown,	1·79	0·06

Another specimen of the last gave for $\dot{H}$ 2·03.

The loss by strong ignition for several Idocrases was as follows:

Slatoust, 2·68, 2·10 p. c.; Bannat, 2·41, 2·41; Wilui, 0·73; Egg, near Christiansand, 2·21, 2·19; Vesuvius, green, 2·80; ib. brown, 2·33, 2·15; Ala, 3·10.

Garnet on the contrary affords only a trace of water. Grossular from Wilui, 0·12; Almandine of Slatoust, 0·00; Red Cinnamon Stone, 0·25, 0·34.

On the crystallographic structure of idocrase as shown by subjection to fluohydric acid by Leydolt, Akad. Wiss. Wien, May, 1855.

Locality at Fahlun in talcose slate, Kenngott, Min. Not., No. 16.

IRIDIUM [p. 13].—The gold of California is well known to be associated with Iridium. Traces of it have remained in the coin of the Philadelphia mint. In a paper by H. Dubois (cited in Ann. d. Mines, [5], vi, 518, 1854), it is stated that the coin had undergone in England a depreciation of four pence per ounce on account of the iridium; and much difficulty had been encountered in using it for jewelry, on account of the hard points, some grains of iridium present in the gold weighing even 40 milligrams. Mr. Dubois proposes effecting the separation by making an alloy of gold with silver, as usual, and then allowing it to stand melted 15 minutes; the iridium, whose specific gravity is 19, will settle to the bottom in an alloy of 12 or 13. A repetition of the process a few times will remove the whole. 20,000 ounces of California gold have thus afforded 21 ounces of iridium.

JAULINGITE, *Zepharovich*. Akad. Wiss. Wien, May, 1855.—Announced as a new mineral resin from the lignite of Jauling. It is in rounded massess in the trunk of a species of pine imbedded in a bed of lignite two feet thick. According to M. Ragsky, the resin consists of two kinds of resins distinct in composition and other particulars.

JUNKERITE [p. 446].—Kenngott confirms the conclusion that Junkerite is Spathic Iron. (Min. Not., No. 14.)

KYANITE [p. 263].—Analysis of Kyanite from Wermland, by J. Igelström: (J. f. pr. Chem., lxiv, 61, from Oefv. Ak. Förh., 1854, p, 66):

$\dot{S}i$ 40·02, $\dot{A}l$ 58·46, $\dot{F}e$ 2·04. G.=3·48.

LAZULITE [p. 404].—Analysis of Lazulite occurring with Svanbergite (see beyond), by Igelström (loc. cit.):

$\dot{P}$	$\dot{A}l$	$\dot{M}g$	$\dot{C}a$	$\dot{F}e$	$\dot{M}n$	$\dot{H}$
42·52	32·86	8·58	*tr.*	10·55	*tr.*	5·30=99·81.

Streak and powder blue. G.=2·78.

LEUCOPHANE [p. 182].—R. P. Greg, Esq., in Phil. Mag. for July, 1855, p. 510, describes and figures a large crystal of Leucophane. Calling O the basal plane, I, I', the left and right lateral planes of the prism, $O : I$ or I' is 90°, $I : I'$ 90°—93° (91° 3′, Brooke and Miller). There is also a plane d on the left basal edge, e on the right, and f on an angle between; $O : d$=118° 30′, $I : d$=154°, $O : e$=117°, $I' : e$=151°, $O : f$=126°—126° 25′, $I : f$=124°, $I' : f$=128° 30′. There is also another plane g $(m{-}n)$ on the angle between O and I', giving $O : g$=140° 50′, $I' : g$=126° 30′, $I : g$=101° 30′. Descloizeaux has shown that the crystal gives two systems of rings, when examined with polarized light perpendicular to O, exactly like topaz. Like topaz it also has cleavage parallel to O, but also two other cleavages, one parallel to f, and another to the vertical diagonal plane in the same zone; the cleavages O and f are inclined at 126°, and O and the diagonal at 90°.

[As the prism is right, $O : d$ and $I : d$ should together make 270°, and so also $O : e$ and $I' : e$. A discrepancy above of 2° to 2½°, shows the allowance which is to be made for imperfect measurements on account of want of smoothness in the planes. Admitting this, we may regard the prism as a trimetric rhombic prism, with $I : I'$ about 91°. d, e, will then be planes of the same octahedron, and f, a macrodome. The form is hence near Andalusite or Æschynite. If d, e, are the octahedron 2, $O : 2$=118° (nearly), $O : 2\breve{1}$=126° 25′, $I : I$=91°. $O : 1\breve{1}$ by calculation is 145° 52′, while it is 144° 33′ in Andalusite, 145° 58′ in Æschynite, and in Natrolite 144° 23′. $O : 2$, by calculation 117° 49′. The plane g $(m{-}n)$ appears to be hemihedral; but the other on the same angle may be suppressed only by distortion, not by true hemihedrism. The cleavages O, f, and the diagonal, are the same as cited in the Mineralogy; the angle 126° 25′ being the supplement nearly of 53½, and 36½ the supplement of the inclination of f on the diagonal plane (*ii*).—J. D. D.]

LIMONITE [p. 131].—Analysis of ore from near the mouth of Niangua, Missouri, by Dr. Litton (Rep. Geol. Mo., 1855), $\dot{F}e$ 83·27, $\dot{H}$ 11·11, $\dot{A}l$ 1·08, $\dot{S}i$ 4·36. From half a mile west of Warsaw (ib.) $\dot{F}e$ 88·65, $\dot{H}$ 10·01, $\dot{A}l$ 0·87, $\dot{S}i$ 2·11, S 1·05=102·89. From near Buffalo (ib.) $\dot{F}e$ 84·80, $\dot{H}$ 11·62, $\dot{A}l$ 0·64, $\dot{S}i$ 2·88, S 0·12=100·06.

Loc. in California, Am. J. Sci., [2], xx, 81; Phœnixville, Pa., ib., xx, 250.

MAGNESITE [p. 441].—Bolton, Lower Canada, T. S. Hunt, Am. J. Sci., xix, 429.

MAGNETITE [p. 405].—Loc. in California. Am. J. Sci. [2], xx, 82.

MALACHITE [p. 458].—Analysis of malachite from Phœnixville, J. L. Smith, Am. J. Sci. [2], xx, 249.

MANGANESE ORE in the Jura.—A. Müller, Verh. Nat. Gesellsch. in Basel, 1844, 95.

MANGANESE SPAR, see *Rhodonite.*

MARCYLITE, *C. U. Shepard.*—A species instituted on a mass rather more than an ounce in weight, looking like black copper, from the south part of the Red River near the Witchita Mountains. H.=3. G.=4–4·1. BB. in small fragments fuses in the flame of a candle, giving it a rich blue and green color, which is still more distinct with the blowpipe; chlorid of copper is volatilized and spreads over the charcoal support; pure copper finally obtained. Powdered mineral almost wholly dissolved in ammonia, giving out muriatic acid. Contains copper 54·30, oxygen and chlorine 36·20, water 9·50=100.—Marcy's Expl. Red River, 8vo, p. 135. Washington, 1854.

A black copper from the same region afforded copper with traces of iron 35·30 (to 40·00), silica 30·60, oxygen and water 34·10=100. (Ib.)

MEIONITE [p. 200].—Measurements of crystals from Vesuvius by Rammelsberg (Pogg., xciv, 434); 1:1 over summit 116° 12′, giving for basal angle 63° 48′ and for pyramidal angle 136° 8′; the last by observation, 136° 12′.

Measurements by Kokscharov (Min. Russl., ii, 105) 1:1=136° 11′ or 136° 10′—136° 11½. *Mizzonite* affords 1:1=135° 58′.

MELANCHYME, *Haidinger.*—A bitumen-like substance of earthy fracture occurring according to Reuss, at Zweufelsreuth in the district of Eger. Kenngott's Min. Forsch., for 1853, p. 134.

MELLITE [p. 475].—Dauber's measurements of mellite from Artern afforded (Pogg. xciv, 410), for the pyramid 118° 14′, whence $a:c=1{\cdot}34:1$: Kupffer obtained 118° 13½′, Kenngott, 118° 16′, G. Rose, 118° 14½′, Breithaupt, 118° 16½, Phillips, 118° 17′.

MICA [p. 217].—Von Kokscharov has measured the biaxial mica of Vesuvius and sustains the conclusion (Min. Russl., p. 126, Pogg. xciv, 212), that it is monoclinic. He obtained as a mean of his results, $I:I=120°\ 45'$, $O:I=98°\ 38'$, $O:1=106°\ 54'$, $1:1=122°\ 50'$, $I:1=154°\ 29'$, $I:i=119°\ 38'$, $O:\frac{4}{3}i=114°\ 29'$, $i:\frac{4}{3}i=155°\ 31'$. $a:b:c=1{\cdot}64656:1:0{\cdot}57735$. C, or inclination of vertical axis $=30°$.

Leydolt has described a *Muscovite* containing crystals of biotite (or rhombohedral mica) in regular positions, the plane of composition being a rhombohedron R^n and a pyramid. He also shows that the striæ and lines and the transverse cleavage, producing what is called prismatic mica, is due to the intercalation of thin plates of mica.

Refraction of mica (muscovite) according to Haidinger, for extraordinary ray, 1·581, for ordinary, 1·613.—Sitz. Wien., xiv, 330.

S. Haughton refers to *Margarodite*, which he sustains as a good species, micas from Ireland, analyzed with the following results (Phil. Mag. [4], ix, 272):

	$\dot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{A}}\mathrm{l}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{N}}\mathrm{a}$	ign.	
1. Dublin Co.	43·47	31·42	4·79	1·38	1·13	10·71	1·44	5·43	=99·77
2. Wicklow Co.	44·71	31·13	4·69	1·09	0·90	9·91	1·27	6·22	=99·92
3. Carlow Co.	44·64	30·18	6·35	—	0·72	12·40	*tr.*	5·32	=90·61
4. (mean)	44·27	30·91	5·27	0·82	0·92	11·01	0·90	6·66	

Oxygen ratio for $\dot{\mathrm{R}}$, $\ddot{\mathrm{R}}$, $\ddot{\mathrm{S}}\mathrm{i}$, $\dot{\mathrm{R}}$, deduced for No. 1, 1·13 : 6·00 : 8·59 : 1·80; for No. 2, 1 : 6 : 8·97 : 2·083; for No. 3, 0·9 : 6·0 : 8·74 : 1·77; for the mean, 1·01 : 6 : 8·66 : 1·89. The author adopts the mean ratio 1 : 6 : 9 : 2, and deduces the formula $\dot{\mathrm{R}}\,\ddot{\mathrm{S}}\mathrm{i} + 2\ddot{\mathrm{R}}\,\ddot{\mathrm{S}}\mathrm{i} + 2\dot{\mathrm{H}}$. The angle between the optic axes is for No. 1, 53° 8′; for 2, 70° 4′; for 3, 72° 18′.

[The oxygen ratio for $\dot{\mathrm{R}}+\ddot{\mathrm{R}}$ and $\ddot{\mathrm{S}}\mathrm{i}$ is 1 : 1·20 in No. 1; and 1 : 1·27 in Nos. 2 and 3.—D.]

MILLERITE [p. 49].—In the Millerite of Joachimstahl, Kenngott observes (Min. Not., No. 14) that the planes of the fundamental hexagonal prism and the one intermediate are distinct.

On some needles of Millerite he found small green rhombohedral crystals giving the angle $R : R = 105° 15'$, which were too few for analysis, but may have been a calcite containing a carbonate of nickel.

MIMETENE [p. 401].—Analyses, etc., Phœnixville, Pa., J. L. Smith, xx, 248.

MISPICKEL [p. 62].—Analyses of Mispickel of Copiapo, by J. L. Smith (Gilliss's Exped., ii, 102): S 20·25, As 44·30, Fe 30·21, Co 5·84 = 100·60.

Mispickel pseudomorphous after Pyrrhotine has been observed by Kenngott, in specimens from Freiberg in Saxony (Min. Not., No. 14).

MOLYBDATE OF IRON (?) [p. 144].—Locality in Heard Co., Georgia, Am. J. Sci. [2], xix, 429.

MORENOSITE, *A. Casares*.—A nickel vitriol occurring in Spain (Hartm. Zeit. vii, 37, and Kenngott's Min. Forsch. for 1853, 16), in needles or thin prisms. Soluble in water, solution green. Reactions indicate $\dot{N}i$, $\bar{S}$, (and also $\dot{H}$?) with mixed $\dot{C}u$ and $\dot{F}e$.

NAPHTHA [p. 469].—On some of the basic constituents of coal Naphtha, by C. Greville Williams, Edinb. N. Phil. J. [2], ii, 324.

NATIVE IRON [p. 17].—The supposed Native Iron of Canaan, Ct., has been analyzed by Dr. A. A. Hayes of Boston, and proved thus to be a furnace product. It contains carbon and affords full evidence that it has been artificially reduced from iron ore.

Dr. Hayes has examined masses of iron purporting to be native, from Liberia, Africa, and finds them absolutely pure from carbon, unlike any artificial iron, and moreover particles of quartz are disseminated through it; and the evidence from these sources and also from the reports that come from Liberia through Americans resident there, appears to be conclusive that the iron is native. The structure of the iron is massive with only very minute crystalline grains. Analysis afforded, pure iron 98·40, quartz grains, magnetic oxyd of iron, and zeolite 1·60 = 100·00. The locality is in the hill country above Bexley, Bassa county, Liberia. It probably occurs in large deposits.

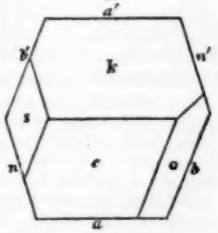
NEPHELINE [p. 232].—Mt. Somma crystals afforded v. Kokscharov, (Min. Russl., ii, 160), $1 : 1 = 139° 17'$, $I : 1 = 134° 5\frac{1}{2}'$, $O : 1 = 135° 54\frac{1}{4}'$. Breithaupt obtained for $I : 1$, 134° 5′; Haidinger, 134° 3′; Scacchi, 133° $57\frac{1}{2}'$.

OKENITE [p. 306].—Mean of two analyses by C. v. Hauer, (Jahrb. geol. Reichs., 1854, 190, Wien): $\dot{S}i$ 54·81, $\dot{C}a$ 27·23, $\dot{M}g$ *tr.*, $\dot{H}$ 18·04 = 100·08, giving the received formula $\dot{C}a^3\,\bar{S}i^4 + 6\dot{H}$.

OSTRANITE [p. 196].—Kenngott confirms (Min. Not. No. 15), by a crystallographic examination, the identity of Ostranite with Zircon. The Ostranite is from Brevig, in Norway.

PARAFFINE (native).—Hofstädter, in J. f. pr. Chem., lxiii, 410).

PAISBERGITE [p. 168].—H. Dauber (Pogg. xciv, 398), describes this mineral as occurring in transparent shining crystals with garnet and chlorite. Crystallization triclinic, the prism affording, the angles $a : b = 111° 8\frac{1}{2}'$, $a : c = 93° 28\frac{1}{2}'$, $b : c = 87° 38'$; and $a : b : c = 1·8291 : 1·1579 : 1$. Cleavage parallel to b and c, nearly equally perfect.



Angles $ac =$	93° 28½′,	$a'k$ 117° 45½′,	ck 148° 47½′,	ab 111° 8½′
an	106° 8½′,	bn' 142° 39½′,	bc 87° 38′,	$b'c$ 92° 22′
oc	136° 8½′,	ob 131° 27′	sc 138° 11½′,	sb' 134° 0½′
nc	94° 36′,	$n'c$ 85° 24′	kb' 102° 58′	ks 139° 43′
ns	126° 11′,	ko 118° 58′	ao 107° 16′	kb 76° 59′

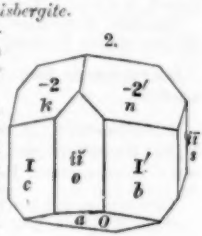
A silicate of manganese from Longbanshytta, Sweden, and Przibram, Bohemia, and the *Fowlerite*, present according to Dauber, a similar form to that of the Paisbergite; the following are the angles he has obtained:

1 Longbanshytta,	$a\,b$=111° 6′	$a\,c$=93° 15′	$b\,c$=87° 18′
2. Przibram,	111°–112°	94° 11′–92° 6′	87° 6′–87° 54′
3. Fowlerite,	111° 38′–112° 6′	92° 21′–93° 38′	86° 11′–88° 17′

These minerals therefore are all referred by Dauber to *Paisbergite*.

[This is an important observation, by Dauber. The cleavage of Fowlerite confirms this determination. The species should properly be called *Fowlerite*, this being the earlier name.

M. Dauber recognizes the approximate similarity in the cleavage (parallel to *b* and *c*) to augite. But by the position he gives the crystals the further resemblance is not seen. The annexed figure shows this relation to be a close one, and exhibits the analogies between the monoclinic and triclinic forms. The lettering assists in a direct comparison of the forms (see Min. p. 159). The following angles show plainly the parallelism.



Paisbergite, Dauber.	*Augite.*	*Paisbergite.*	*Augite.*
$b\,c$ (I : I') = 87° 38′	I : I = 87° 5′	$b\,s$ (I' : $i\!i$)=134° ½′	I : $i\!i$=136° 27½′
$c\,k$ (I : −2)=148° 47′	I : −2=144° 35′	$c\,s$ (I : $i\!i$)=138° 11½′	I : $i\!i$=136° 27½′
$b\,n$ (I' : −2′)=142° 39½′	I : −2=144° 35′	$o\,a$ ($i\!i$: O)=107° 16′	$i\!i$: O=106° 1′
$c\,o$ (I : $i\!i$) =136° 8½′	I : $i\!i$ =133° 32½′	$b\,a$ (I' : O)=111° 8½′	I : O=100° 57′
$b\,o$ (I' : $i\!i$)=131° 27′	I : $i\!i$ =133° 32½′	$c\,a$ (I : O)= 93° 28½′	I : O=100° 57′

J. D. D.]

Pectolite [p. 305].—In a paper by M. F. Heddle and R. P. Greg, Esq., (Phil. Mag. [4], ix. 248), we learn that Thomson's "Stellite" is undoubtedly pectolite, as well also as his "Wollastonite" from Kilsyth, the mineral from Costorphine Hill analyzed by Walker, the "Wollastonite" from the Castle Rock of Edinburgh analyzed by Kennedy. Other English localities are Talisker in Skye, Girvan and Knockdolian Hill in Ayrshire, and Ratho near Edinburgh. The Ratho mineral occurs with steatite, calcite, barytes, and as pseudomorphs after analcime. Analyses by Dr. Heddle, and others cited by him (loc. cit.):

	$\dot{S}i$	$\dot{C}a$	$\dot{N}a$	$\dot{H}$	$\dot{A}l$, $\dot{F}e$, $\dot{M}g$, $\dot{K}$	
1. Kilsyth,	52·74	31·68	9·60	2·00	3·39	*Thomson.*
2. Costorphine Hills,	54·00	30·79	5·55	5·43	2·59 ($\dot{M}g$)	*Walker.*
3. Castle Rock,	51·50	32·00	8·50	5·00	1·00	*Kennedy.*
" "	53·06	33·48	9·98	3·13	0·75	*Heddle.*
5. Ratho, *fibrous*,	52·53	32·79	9·75	3·04	0·88 ($\dot{A}l$)	*Heddle.*
6. " *crystalline*,	52·58	33·75	9·26	2·80	1·46 "	*Heddle.*
7. Knockdalian Hill,	53·24	32·22	9·57	3·60	1·00 "	*Heddle.*
8. Talisker,	53·82	29·88	9·55	3·76	2·73	*Heddle.*
9. Girvan,	53·48	34·38	9·88	3·26	0·42	*Heddle.*
10. Bishoptown,	52·07	32·80	9·60	2·00	4·20	*Thomson.*
11. Bavaria, *Osmelite*,	52·91	32·96	6·10	4·01	0·86, $\dot{K}$ 2·79,	*Adam.*

Dr. Heddle deduces from the Ratho analyses, the oxygen ratio for $\dot{N}a$, $\dot{C}a$, $\dot{S}i$, $\dot{H}$, 1 : 4¼ : 11 : 1, which he takes at 1 : 4 : 11 : 1 and writes the formula $3\dot{N}a\,\dot{S}i + 4\dot{C}a^3\,\dot{S}i^2 + 3\dot{H}$ =Silica 52·57, lime 34·95, soda 9·68, water 2·80=100. He reckons the $\dot{A}l$ with $\dot{C}a$.

The Ratho crystals are oblique 4-sided prisms, twinned sometimes parallel to a face of perfect cleavage c; of the other two faces u and y, u is a face of perfect cleavage, $c : u$=95° 23′, $c : y$=54° 05′, $y : u$=93° 30′.

[Recalculating the oxygen ratio, we obtain, taking for the equivalent of silica 577·31, 1 : 4·22 : 11·43 : 1·04; whence for $\dot{R} : \dot{S}i$, 5·22 : 11·43=4 : 8·76, or near the hornblende ratio. Taking 566·25 as the equivalent of silica, we have for $\dot{R} : \dot{S}i$, 5·22 : 11·65=4 : 8·93, which is still nearer 4 : 9. $\dot{R}^4\dot{S}i^3 + \dot{H}$ is hence as near the analyses as that deduced above, it corresponding (if $\dot{N}a$ to $\dot{C}a$=1 : 4 and $\dot{S}i$=577·31,) to, Silica 52·9, lime 34·2, soda 9·5, water 3·4=100. The form approximates to that of Paisbergite.—In the Mineralogy, p. 306, 3d l. from top, for *alumina*, read *lime*.—J. D. D.]

PENNINE [p. 295].—Haidinger has shown that the crystallization of Pennine is rhombohedral (Pogg., xcv, 620); he found for the refraction of the extraordinary ray 1·575, of the ordinary 1·576. Angle of the rhombohedron by measurement 67° 24′.

PEROFSKITE [p. 345].—This mineral occurs in the valley of Zermatt, Switzerland, according to Damour (Ann. des Mines, [5], vi, 512). Color pale yellow, honey yellow, orange yellow, sometimes reddish brown; semi-transparent, and thin fragments sometimes transparent. Streak or powder, white. A druse of minute transparent cubes observed on one specimen. G.=4·037—4·039. H.=5·5. Attacked by hot muriatic acid and partially dissolved; not acted on by nitric acid; sulphuric acid at 300° C. decomposes it entirely, dissolving the titanic acid and forming sulphate of lime. Mean of two analyses: titanic acid 59·23, lime 39·92, protoxyd of iron 1·14 =100·29, affording the constitution $\dot{C}a\,\dot{T}i$. The other minerals of this locality are garnet, idocrase, diopside, chlorite, ripidolite, serpentine, sphene, zircon, corundum, rutile, magnetic iron, titanic iron.

The planes of the crystals of Perofskite from the Urals, stated to be $\frac{3}{2}$-$\frac{3}{2}$ and $\frac{2}{1}$ are, according to Kokscharov (Min. Russl., 1854, i, 199), 2-2 and 3-3.

PHOSPHORCHALCITE [p. 425].—Aanalysis of Lunnite from Cornwall, by Dr. Heddle (Phil. Mag., [4], x, 39):

$\dot{P}$ 22·73 $\dot{C}u$ 68·13 $\dot{H}$ 8·51 mixed quartz 0·48=99·85

consists of aggregated congeries of minute spheres; G.=4·25.

The presence of a trace of selenium in this ore from Rheinbreitenbach has been confirmed by Bödeker (Ann. d. Ch. u. Pharm., xciv, 356). He obtained one-sixth grm. from 50 grammes of the ore.

PLAGIONITE (Min. 75).—A crystal from Wolfsberg, presenting the planes *O*, 2, *ii*, and another of *O*, 2, are figured by Kenngott (Min. Not., No. 16).

PLATINUM [p. 12].—Loc. at Pt. Orford, California. Am. J. Sci., [2], xx, 79.

POLYHALITE [p. 377].—An analysis by Dr. G. Jenszch (in the laboratory of Prof. H. Rose), of a specimen that came from Berthier, and is now in the museum of the Berlin Academy, afforded, on calculating from the results (Pogg. xciv, 175):—

$\dot{C}a\,\ddot{S}$	$\dot{M}g\,\ddot{S}$	$\dot{K}\,\ddot{S}$	$\dot{N}a\,\ddot{S}$	Na Cl	$\ddot{S}i$	$\dot{F}e$	$\ddot{A}l$	$\dot{M}g$	$\dot{H}$	
44·11	19·78	25·87	1·69	0·24	0·11	1·01	0·39	0·02	6·16	=99·38,

proving that this dark red mineral from Vic is Polyhalite.

PREHNITOID, Blomstrand (Oefv. Akad. Förh., 1854, p. 296).—Massive and columnar. Pale green. Lustre vitreous. H.=7. G.=2·50. BB. fuses easily to a white enamel, acting like prehnite. Mean of 5 analyses:

	$\ddot{S}i$	$\ddot{A}l$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	$\dot{M}g$	$\dot{F}e$	$\dot{M}n$	ign.	
	56·00	22·45	7·79	10·07	0·46	0·36	1·01	0·18	1·04	=99·36
Oxygen	29·08	10·49	2·21	2·58	0·08	0·14	0·22	0·05		

Oxygen ration for $\dot{R}$, $\ddot{R}$, $\ddot{S}i$, 5·28 : 10·49 : 29·08=1 : 2 : 6=3$\dot{R}\,\ddot{S}i$+$\ddot{A}l^2\,\ddot{S}i^3$.

[As the oxygen ratio of $\dot{R}$, $\ddot{R}$ and $\ddot{S}i$ is 1 : 2, we may write in place of this improbable formula, (combining silicates of the ratios 1 : 3 and 6 : 9,) the augite formula ($\dot{R}^3$, $\ddot{R}$) $\ddot{S}i^2$, or more precisely ($\frac{1}{3}\dot{R}^3$+$\frac{2}{3}\ddot{R}$) $\ddot{S}i^2$=$\dot{R}^3\ddot{S}i^2$+$2\ddot{R}\,\ddot{S}i^2$, in which it approaches spodumene, the oxygen ratio of the protoxyds and peroxyds in the latter being 1 : 4 instead of 1 : 2.—J. D. D.]

PROSOPITE [p. 502].—Composition and pseudomorphous character of crystals, G. J. Brush, Am. J. Sci., xx, 273.—Ibid., J. D. Dana, 274. The crystals examined consisted partly of kaolin and partly of fluor spar.

Scheerer in J. f. pr. Chem., lxiii, 450, endeavors to sustain his deduction respecting the analogies in the formulas of barytes and prosopite, notwithstanding the want of a complete analysis and a wide difference in the crystalline forms. As the formula of barytes is BaO, SO^3, so he writes for prosopite CaF, $\dot{A}l\,\dot{F}^3$, $\dot{H}$. The conclusion involves the extraordinary supposition that Al and S are isomorphous.

PYROMORPHITE [p. 400].—Loc. Phœnixville, Pa., Smith, Am. J. Sci., xx, 247.

PSEUDOPHITE, Kenngott, Min. Not., No. 17.—Has the appearance of serpentine. Compact with conchoidal fracture. Color grayish, olive or pistachio green; streak white; lustre weak. Feel somewhat greasy. H.=2·5. G.=2·75—2·77. BB. becomes white or yellow, but is infusible. In muriatic acid, imperfectly soluble and forming no jelly. Composition:

$\dot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}g$	$\dot{H}$
33·51	15·42	2·58	34·41	13·21 (of which 0·46 lost at 100° C.)

Affording the oxygen ratio for $\dot{H}$, $\dot{R}$, $\dot{R}$, $\dot{S}i$, 9 : 12 : 6 : 15.

PYRORETIN [1st Suppl.].—This resin is apparently identical with that described by Dr. Mallet under the name of *Scleretinite* (Phil. Mag., [4], iv, 261, and Min., 468). Excluding the ash of the latter, Dr. Mallet's first analysis afforded carbon 79·99, hydrogen 9·18, oxygen 11·11, and the second gives a similar result, and both the same formula with the pyroretin. (Mallet, in a letter to the Author.)

PYROXENE [p. 158].—Analysis of pyroxene from the Eiffel, and of a mica pseudomorph after the augite by Th. Kjerulf,

	$\dot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	ign.
1. Augite,	50·21	6·94	7·59	19·85	13·66	0·33=98·58
2. Mica pseud.,	43·10	15·05	23·25	0·81	10·82	1·50, with $\dot{K}$ 4·62, $\dot{N}a$ 0·82, and $\dot{T}i$ 1·03 as impurity with the mica.]

A Diallage from Achmatowsk according to Hermann contains (Bull. Soc. Imp. Nat. Moscou, 1854, p. 273):

	$\dot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$
	51·47	1·15	1·80	27·81	15·63	2·39
Oxygen	26·72	0·51	0·40	7·89	6·13	2·12

Form of crystal ∞, ∞-3, ∞-∞, 0, or in letters, *I*, *i*3, *ii*, *O*. Cleavage *ii* very perfect, with a sub-metallic inclined to vitreous lustre. H.=4·5. G.=3·21.

Analyses of *Hypersthene* from a Hypersthene rock of Silesia by G. von Rath (Pogg., xcv, 541):

	$\dot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	ign.	
1. Black,	51·78	1·12	10·97	20·04	15·58	0·22=99·71.	G.=3·336
2. Dark gn.,	50·34	——	8·47	21·85	16·86	1·23=98·76.	G.=3·249
3. Dark gn.,	50·00	0·42	8·54	21·11	15·87	1·69=97·63.	G.=3·244

Oxygen ratio for $\dot{R}$ and $\dot{S}i$ in No. 1, 1 : 1·87; in 2, 1 : 1·75; in 3, 1 : 1·85.

Von Rath observes that the earlier analyses of Diallage, given in Rammelsberg's Handwörterbuch, and another in the 2nd Supplement, conduct to the same ratio.

A Diallage from Gabbro, in Silesia, afforded $\dot{S}i$ 53·60, $\dot{A}l$ 1·99, $\dot{F}e$ 8·95, $\dot{M}n$ 0·28, $\dot{C}a$ 21·06, $\dot{M}g$ 13·08, ign. 0·86=99·82, giving the oxygen ratio 13·46 : 0·93 : 27·85.

See further *Enstatite*.

On a serpentine-like pseudomorph of diopside, Kenngott, Min. Not., No. 17.

PYRRHOTINE [p. 50].—Note on formula of pyrrhotine, T. S. Hunt. This Journal, [2], xix, 428.

QUARTZ [p. 145].—Density according to Deville before heating 2·663; after fusion 2·220, showing a diminution of 0·17. In a similar manner labradorite shows under the same circumstances a diminution of 0·06, orthoclase of 0·08, hornblende of 0·12, pyroxene of 0·14, iron chrysolite of 0·16. Corundum 4·022 before fusion, 3·992 after fusion.

Memoir on the crystallization of quartz, by M. Descloizeaux, Acad. Sci., May, 1855, a paper of great value, containing figures and descriptions of numerous new crystalline forms, etc. See a notice in this Jour., xx, 270.

Prof. F. Leydolt has published (Sitz. Wien, xv, 59) an important paper on the structure of quartz crystals as developed by the action of hydrofluoric acid, illustrated by plates and wood cuts.

On the tetartohedrism of quartz, Kenngott, Min. Not., No. 15.

SALT [p. 90].—Loc. in California, Am. J. Sci., [2], xx, 83.

Pseudomorphs in hopper-shaped crystals, &c., Nöggerath, Verh. nat. Ver., Bonn, 1854, p. 385.

SARCOLITE [p. 200].—Measurements by Kokscharov (Min. Russl., ii, 110), *O* : 2= 128° 38′. *O* : 2*i*=138° 30′.

SAUSSURITE [p. 254].—According to von Rath (Pogg., xcv, 555) the Saussurite from the greenstone of Neurode in Silesia, has the cleavage, hardness, and tabular twins of Labradorite; color mostly porcelain white. G. in powder, 2·998, in small fragments 2·991.

	$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	ign.
	50·84	26·00	2·73	14·95	0·22	0·61	4·68	1·21 = 101·24
Oxygen	26·42	12·14	0·82	4·26	0·09	0·10	1·21	

Forms with hornblende (uralite) the greenstone of Neurode; see hornblende above.

SCAPOLITE [p. 201].—Kokscharov makes $O:1$ in scapolite 148° 10′, 1 : 1=136° 11′. (Min. Russl., ii, 82.) Se farther, *Meionite.*

In Am. J. Sci., [2], xix, 428, and Phil. Mag., [4], ix, 382, Mr. T. S. Hunt gives some results, and aims to show that *Wilsonite* is a distinct species.

In Am. J. Sci., [2], xx, 269, a reëxamination of *Wilsonite,* by E. J. Chapman, showing that its crystallization and other characters are those of Scapolite.

SCHEERERITE [p. 471].—Crystallization according to Kenngott (Min. Not., No. 15) of the Scheererite of Uznach in Switzerland, monoclinic; crystals very small, thin, and slender prismatic, having a hemipyramid in front and a hemidome behind at the extremity. Front edge of prism on face of hemidome 101° 30′; on edge of hemipyramid 123° 30′.

SCLERETINITE.—See *Pyroretin.*

SERPENTINE [p. 282].—Analyses by S. Haughton (Phil. Mag., [4], x, 253) of the serpentine (1.) of Cornwall called serpentine porphyry, the red earth base being taken: (2.) of Galway; (3.) of Zermatt, Switzerland; (4.) of Syria:

	$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}g$	$\dot{H}$	$\dot{C}$	
1.	38·29	——	13·50	34·24	12·09	——	= 98·12
2.	40·12	*tr.*	5·47	40·04	13·36	2·00	= 98·99
3.	42·88	——	3·80	40·52	12·64	——	= 99·84
4.	41·24	——	7·41	36·28	14·16	——	= 99·09

A so-called soapstone from Cornwall, afforded Mr. Haughton (loc. cit.), $\ddot{S}i$ 42·47—42·10, $\dot{A}l$ 6·65—7·67, $\dot{M}g$ 28·83—30·57, $\dot{H}$ 19·37—18·46. Oxygen ratio deduced for $\dot{R}$, $\dot{R}$, $\ddot{S}i$, $\dot{H}$, 1 : 0·27 : 1·92 : 1·49 and 1 : 0·27 : 1·8 : 1·34.

SILVER ORES.—Ores of Chili, J. L. Smith in Gilliss's Exped., ii, 94.

SMALTINE [p. 56].—Analysis of specimen from Atacama by J. L. Smith (Gilliss's Exped., ii, 102):

As 70·85 Co 24·13 Fe 4·05 Cu 8·41 Ni 1·23 S 0·08=100·75.

Kenngott has observed cubic crystals of Smaltine, whose faces were convex and presented distinct traces of planes of a tetrahexahedron (Min. Not., No. 14, Sitz, Wien, xiii, 462).

SODALITE [p. 229].—Loc. in Russia, Kokscharov (Min. Russl., i, 224).

SORDAWALITE [p. 177].—Analysis by Wandesleben (N. Jahrb. Pharm., i, 33, in Lieb. u. Kopp., 1854, 842):

$\ddot{S}i$ 47·70 $\dot{A}l$ 16·65 $\dot{F}e$ 21·32 $\dot{M}g$ 10·21 $\dot{P}$ 2·26=98·14

SPINEL [p. 103].—Loc. in Russia, Kokscharov (Min. Russl., i, 211).

STEPHANITE [p. 86].—Crystallization of Stephanite by F. H. Schrœder (Pogg., xcv, 257). An elaborate paper describing many new forms, simple and compound, giving a large number of angles. The following are the simple forms: O, $\breve{\imath}$, $8\breve{\imath}$, $\frac{1}{2}\breve{\imath}$, $7\breve{\imath}$, $4\breve{\imath}$, $2\breve{\imath}$, $1\breve{\imath}$, $\frac{2}{3}\breve{\imath}$, $i\breve{1}1$, $\frac{2}{7}\breve{1}1$, $3\breve{9}$, $\frac{1}{2}\breve{7}$, $1\breve{5}$, $\frac{5}{2}\breve{5}$, $1\breve{5}$, $8\breve{4}$, $i\breve{3}$, $\frac{3}{2}\breve{3}$, $1\breve{3}$, $\frac{3}{4}\breve{3}$, $4\breve{2}$, $\frac{4}{3}\breve{2}$, $\frac{1}{3}\breve{1}\frac{3}{7}$, $5\breve{\frac{5}{3}}$, $\frac{5}{2}\breve{\frac{5}{3}}$, $6\breve{\frac{3}{2}}$, I, 1, $\frac{2}{3}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $i\breve{3}$, $3\breve{3}$, $\frac{3}{2}\breve{3}$, $i\breve{1}$, $1\breve{1}$.—The angle $I:I$= 115° 39′, $O:1$=127° 51′.

SULPHUR [p. 22].—Loc. in California, Am. J. Sci., [2], xx, 84.

SVANBERGITE.—Announced as a new mineral by Igelström (Oefv. Ak. Förh., 1854, p. 156, and J. f. pr. Chem., lxiv, 252). Occurs in Wermland, in a gangue with kyanite, pyrophyllite, mica, quartz, and iron glance. Crystallization monoclinic,

semitransparent. Cleavage distinct and parallel to the base. Color, and color of powder, pale red. G.=3·30. H.=5. Composition according to Igelström:

S	P	Al	Ca	Fe	Na	H	Cl
17·32	17·80	37·84	6·00	1·40	12·84	6·80	*tr.*

BB. on coal fuses only on the thinnest edges: a red hepatic mass with soda in the reduction flame, which becomes green with water, and with dilute acid develops sulphuretted hydrogen. In borax easily soluble to an iron-colored glass. With salt of phosphorus a colorless glass. With cobalt solution fine blue.

Sylvine [p. 90].—The occurrence of pure chlorid of potash at Vesuvius with remarks, A. Müller, Verh. Nat. Gesselsch. in Basel, 1854, 113. It is without a trace of lime, magnesia, and alumina and contains only a trace of soda.

Tannerite [p. 73].—This species is named *Emplektite* by Kenngott in his Min. Forsch. for 1853, published in 1855.

TAURISCITE, *Volger.* A new iron-vitriol. Description by G. H. O. Volger (Leonh. u. Bronn. Jahrb., 1855, p. 152). Trimetric. In slender white or glassy prisms; form near that of epsomite. Occurring planes, $\infty\text{-}\breve{\infty}$, $1\text{-}\breve{\infty}$, $\infty\text{-}\breve{2}$, $2\text{-}\breve{2}$, ∞, 2, 1, $2\text{-}\breve{2}$, $\infty\text{-}\breve{\infty}$, $1\text{-}\breve{\infty}$, or in letters, $i\breve{i}$, $1\breve{1}$, $i\breve{2}$, $2\breve{2}$, I, 2, 1, $2\breve{2}$, $i\breve{i}$, $1\breve{1}$. Formed along with Melanterite from the decomposition of pyrites, in the Windgalle, St. Gothard.

Tennantite [p. 84].—A mineral probably tennantite at Lancaster, Pa., W. J. Taylor, in Am. J. Sci., xx, 412.

Tetrahedrite [p. 82].—Analysis of a Tetrahedrite, containing quicksilver, by G. von Rath (Pogg., xcvi, 322).

	S	As	Bi	Sb	Cu	Pb	Zn	Fe	Hg	
1.	22·54	3·18	0·96	18·56	35·42	(0·21)	0·64	0·80	17·27	= 99·58
2.	22·11	3·13	0·66	19·54	34·83	0·21	0·75	0·99	(17·27)	= 99·51
3.	22·94	2·50	(0·96)	19·93	35·76	(0·21)	0·67	0·81	(17·27)	=101·05

Sulphur of arsenic, bismuth and antimony, to sulphur of other metals, as, (1), 2·95 : 4; (2), 3·04 : 4; (3), 2·95 : 4. Formula $4MS+(Sb, As, Bi)^2S^3$, in which $\dot{M}$ is to the sum of the other basic metals as 2·5 : 1.

Specimen a crystal weighing about 13 grammes. G.=5·070, or in powder 5·356. Color light steel gray.

Von Rath also reviews the earlier analyses.

Analysis of Tetrahedrite of Freiberg, Saxony, by J. Wandesleben (N. Jahrb. Pharm., ii, 105, and Lieb. u. Kopp, 1854, 814). S 27·27, Sb 17·40, As 2·40, Cu 42·02, Fe 8·41, Zn 1·89, Ag 0·06=99·45.

Analysis of the ore from Chile by J. L. Smith (Gilliss's Exped., ii, 91): S 26·83, Sb 23·21, As 3·05, Cu 36·02, Fe 2·36, Zn 4·52, Ag 3·41=99·40.

The ore from Coquimbo analyzed by F. Field has been named *Fieldite* by Kenngott, Min. Forsch., for 1853, p. 126.

Titanic Iron [p. 115].—Analysis of ore from Wermland, by J. Igelström (J. f. pr. Chem., lxiv, 62). $\dot{T}i$ 15·76, $\dot{F}e$ 84·24. Occurs in quartz rock in small grains.

Tombazite.—According to Kenngott (Min. Not., No. 14), Trombazite from Lobenstein is much like Nickeline, or nickel green, having a greenish color and giving out arsenous acid before the blowpipe in a glass tube, with no sulphur; and on charcoal it acts like nickeline.

Tourmaline [p. 270].—Kenngott describes a compound crystal of Tourmaline from Brazil, which consists of an interior triangular prism with replaced edges (∞P) enclosed by the hexagonal prism $\infty P2$, only on three edges of which occur the planes ∞P.

Loc. of tourmaline in California, Am. J. Sci., [2], xx, 84.

Zeuxite is referred to this species by R. P. Greg (Phil. Mag., [4], x, 118).

Vanadate of Lead [p. 362].—Analysis of vanadate from Phœnixville, Pa., J. L. Smith, xx, 246.

Vosgite, see *Feldspar.*

Websterite or Aluminite [p. 389].—The so-called paraluminite, according to Kenngott, is nothing but aluminite (Min. Not., No. 16).

WILSONITE, see *Scapolite.*

WÖLCHITE [p. 82].—The Wölchite from St. Gestrand, occurs according to Kenngott (Min. Not., No. 14) in trimetric prisms, affording the planes, ∞, ∞-$\breve{\infty}$, m-$\breve{\infty}$, m'-∞, O, or in letters *I*, *i*̆*i*̆, *m*̆*i*, *m'i*̆, *O*. $I : I = 93° 30'$, $O : mi = 146\frac{1}{2}°$, $O : m'i = 141°$ approximately. G.=5·828. The form is near that of Bournonite, but the composition appears to be different. Analysis by Schrotter, recalculated by Kenngott.

S	As	Sb	Cu	Pb	Fe
28·47	6·04	16·65	17·35	29·93	1·35=99·79

corresponding to 17·8 sulphur, 0·8 As^2, 1·3 Sb^2, 2·7 Cu, 2·9 Pb, 0·5 Fe, or 17·8 S, 2·1 As^2+Sb^2, 6·1 Cu+Pb+Fe. Kenngott takes the ratio as at 8S : 1 (As^2, Sb^2) : 3(Cu, Fe, Pb). It is more nearly 9 : 1 : 3; but the mineral requires a new investigation.

WOLFRAM [p. 351].—The analysis, Suppl. I, p. 18 (this Jour., vol. xix, p. 370) is by Petzold in a notice by Schneider.

WOLLASTONITE [p. 156].—Analysis of Wollastonite from the Morne Mts., by Mr. F. Heddle (Phil. Mag., [4], ix, 452):

	Si	Fe	Ca	Mg	H	C
1.	51·36	0·98	42·50	0·48	1·48	*undet.*
2.	50·43	0·84	43·92	0·40	1·36	2·37 =99·32

The mineral contains a little mixed carbonate of lime.

WULFENITE [p. 349].—Analysis and crystal of Wulfenite from Phœnixville, Pa., J. L. Smith, xx, 245.

XENOTIME [p. 401].—Twin of Xenotime with Malacone, Zschau, Am. J. Sci., xx, 273.

ZAMTITE, *A. Casares.*—Supposed to be a hydrous carbonate of nickel, but not yet analyzed. Resembles the emerald nickel, and is from Spain. Color dull emerald-green. Not crystallized. May be scratched with a knife. Powder apple-green. Lustre waxy, or somewhat vitreous. BB. blackens but does not fuse; with soda and a little borax affords a metallic globule of a dull yellow color; which is magnetic and has the properties of nickel. In a tube yields water. Kenngott's Min. Forsch. for 1853, p. 22. [See Min., p. 457.—D.]

ZEUXITE [p. 270].—See Tourmaline.

ZINCITE (or RED ZINC ORE) [p. 110].—Isomorphism with Greenockite, Kenngott, Min. Not., No. 17.

ART. XXV.—*On a new locality of Meteoric Iron, in the Orange River Country, South Africa, and a supposed new locality of the same, in Mexico*; by CHARLES UPHAM SHEPARD, M.D.

THIS fine meteoric iron mass was brought to London from the Cape of Good Hope, in August last, by the master of a Scottish ship, to whom it had been intrusted by a farmer of the Orange river district, where the mass is supposed to have been recently discovered. It was taken directly to Prof. Tennant, by whom it was purchased; and a few days subsequently was transferred to my possession,—this being the second large metallic meteorite from Africa, which I owe to the same source.

Its weight is 328 pounds. Its figure in one position, as shown by the drawing of Mr. Robert Bakewell here given, is somewhat cubical or block-like, though exhibiting very blunt edges, and upon one side, a very remarkable gash, or reëntering angle.

The indentations of the surface are strongly marked. The depressions are large, and strikingly uniform throughout in their dimensions.

Upon the top of the mass, as represented in fig. 1, there is a broad plate-shaped depression (itself made up of many smaller ones), which is surrounded at its brim with a double series of elongated concavities, each one of which points with its longer diameter, towards the centre of the general concavity. There are no sharp edges or asperities connected with the block, for which reason, it reminds one of a freshly made and highly perfect casting of bronze or of cast-iron.

There is also an almost perfect absence of oxydation over the entire surface, which in place of the usual coating of hydrated oxyd of iron, exhibits a thin black crust, closely adhering to the mass, and not thicker than wrapping paper. In this respect it strikingly resembles the Braunau meteoric iron; and leads to the surmise that the mass is of recent origin.

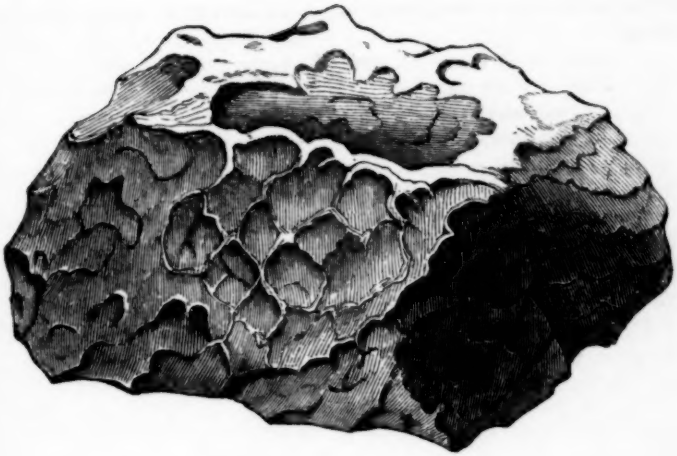
Fig. 2. represents the block in an inverted position, which owing to an anvil-like projection of one of its angles, produces some modification in its general appearance. It brings into view also, a singular opening (*a*) perfectly circular in form, and about three quarters of an inch in diameter, and the same in depth. This opening is slightly concave at bottom, and has at its centre a small projecting pimple; the whole seems to have been wrought artificially; and yet it bears no mark of any tool or instrument, by which it could have been done.

It is sawed with less difficulty than most meteoric irons, being unusually homogeneous in its texture. It is perfectly crystalline in structure, throughout; and apparently the crystallization of the entire block is conformable to the planes of a single individual. Cleavages are effected with facility, giving rise to octahedral and tetrahedral fragments. The polished surfaces show no tendency to oxydation before or after etching; and present an uncommonly white color. When etched, it reveals a regularity of crystallizations wholly unsurpassed; and most resembles that of the Putnam county (Ga.) iron, although the lines and bands of the Orange River iron are much bolder and more strongly marked, than in that from Georgia.

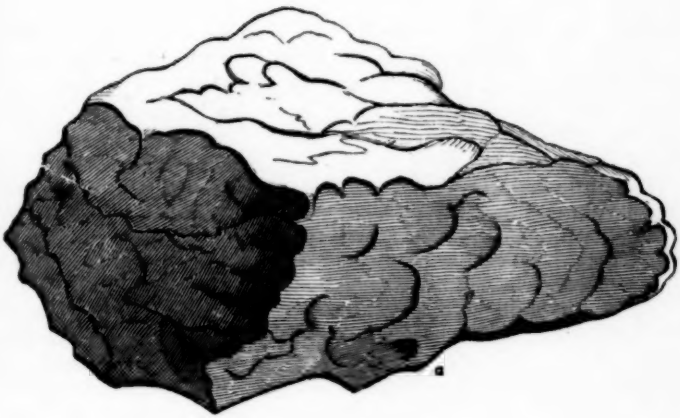
The specific gravity, as determined upon a single specimen weighing sixty grains, is 7·3. But I believe this below the average; and a more satisfactory determination of this property is reserved to a future occasion.

Thus far, I have discovered no indication of the presence of sulphur. No examination was made for tin or copper. In dissolving in dilute nitro-hydrochloric acid, a small residuum was left, which consisted chiefly of nearly round, semitransparent grains of a mineral, which I consider identical with chladnite;

1.



2.



and the same as found, though much more abundantly, in the Tucson, Sonora iron. The remainder of this insoluble matter was composed of Schreibersite, through which were diffused a few minute specks of chromite. The following result was obtained:

Iron, with traces of chromium, - -	90·48
Nickel with traces of Cobalt, - -	8·94
Chladnite, - - - - -	0·56
Schreibersite, - - - - -	0·02
Chromite, - - - - - -	*traces*
	100·

A Supposed new locality of Meteoric Iron in Mexico.

When landing the above described iron from the steamer on my arrival at New York, it accidentally fell under the observation of Mr. Peter McDermot, a deputy custom-house officer, whose attention was arrested by its perfect coincidence in size and general configuration with a mass he had seen in 1847 at Ceralvo, a town situated halfway between Camargo and Monterey, on the great road from this country to Mexico. Mr. McDermot was then a first sergeant in the United States service; and met with the mass in a well known blacksmith's shop at Ceralvo. It was there used as an anvil, one of its faces having been smoothed off to fit it for the purpose. His curiosity was much excited at the time, by the peculiar indentations upon the surface of the mass: and never having seen anything of the kind before, he was led to doubt whether the metal was really iron. Being a blacksmith by trade, he made a cut into its side with a cold chisel, in order to satisfy his curiosity upon the subject. The experiment left no doubt in his mind, that it was composed of soft, tough iron. He had never seen or heard of an undoubted specimen of meteoric iron except on the present occasion; and after inspecting it, felt no doubt that the anvil he had examined at Ceralvo belonged to the same class of objects, and had a similar origin. It is to be hoped, that this notice may lead to an early recognition and testing of the iron seen by Mr. McDermot.

ART. XXVI.—*On the Theory which attributes the Zodiacal Light to a Nebulous Ring surrounding the Earth;* by F. A. P. BARNARD, LL.D., Professor of Mathematics and Astronomy in the University of Mississippi.

AMONG the papers read before the American Association for the Advancement of Science, at the recent meeting in Providence, no one excited a more general interest than that presented by the Rev. George Jones, of the United States Navy, on the subject of the Zodiacal Light. The entire absence of any previous record of continuous and persevering observations upon this well known but little understood phenomenon, rendered peculiarly acceptable the large collection of delineations of its phases as seen from hour to hour and from night to night, during a long period of time, and encouraged the expectation that materials might be found to have at length been gathered for the construction of a theory of the phenomenon which should be completely satisfactory. In this anticipation and hope, the present writer partook quite equally with others; nor is he yet prepared to adopt a different opinion. If the voluminous records submitted to the Association by Mr. Jones, and which carry along with them abundant evidence of the ability and the fidelity with which they were prepared, have not yet suggested the true explanation of the remarkable appearance to which they relate, they must be regarded, in their fullness and their minuteness, as holding out encouraging promise that it will yet be found in them. That collection, indeed, embraces the only mass, large or small, of well ascertained facts, which has yet been brought together on this subject: and even if no speculations whatever had yet been put forth in regard to the significancy of those facts, the publication of the whole would be urgently demanded in furtherance of the interests of science. Since, however, they have been presumed by many, who have studied them attentively, to favor a particular theory in regard to the source of the light, and since that theory, as briefly explained by Mr. Jones at the meeting referred to, was received with marked approbation, and without a single expression of doubt or dissent from any one present, the desirability of the early publication of the entire mass of graphic delineations, with all the accompanying memoranda, is rendered still more urgent.

The writer yields to no one, in his admiration of the zeal, perseverance and manifest ability with which the observations of Mr. Jones were followed up; or of the minuteness of detail with which all the simultaneously accompanying meteorological facts were registered. Nor can he refrain from expressing the gratification which he felt, at the entire freedom from bias with which

the observer seemed to have entered on his task; and the resolute determination displayed by him to ascertain, first of all, the facts, no matter to what conclusions they might lead. The conclusions, however, to which they *have* led in the mind of Mr. Jones himself, and apparently in the minds of most of those who had the pleasure of listening to his explanations, are attended, as the writer is forced to believe, with some difficulties, which it is the design of this communication to set forth. These difficulties would have been brought to the notice of the Association, during the meeting, but that the authority by which the theory of Mr. Jones was so immediately and so emphatically endorsed, presented a front too imposing, and too entirely undivided, not to induce hesitation, and awaken some distrust of objections which were then but the suggestions of the moment. Reflection, however, has had no other result but to confirm the convictions of the writer in the validity of those objections; and it is on this account that they have been finally reduced to the present form, in the hope that, if they are ill-founded, their fallacy may be made to appear.

Before proceeding farther, it is proper to state, specifically, what is the hypothesis of Mr. Jones, which it is proposed here to examine; for though a statement of this hypothesis is to be found in a former number of this Journal, (No. 58, July, 1855,) some months have now elapsed since it appeared. Mr. Jones accounts for the phenomenon known as the zodiacal light, on the supposition that it is a reflection* of the sun's light from a nebulous ring encircling the earth, having its plane coincident with that of the ecliptic, and possessing a density too feeble to intercept the light of the stars. This hypothesis is deduced from the observations, not so much by showing that they embrace an irresistible mass of evidence in its favor, as by gathering from them proofs to invalidate all other hypotheses heretofore suggested to account for the same phenomenon. If the existence of "the earth's ring" has been demonstrated, the demonstration is mainly indirect. Its principal points are embraced in the following propositions.

1. The light, whatever be its source, cannot proceed from a body enveloping the earth.

2. It cannot proceed from a body concentric, whether as an atmosphere or as a ring, with the sun, and interior to the earth's orbit.

3. It cannot proceed from a ring concentric with the sun and exterior to the earth's orbit.

4. It cannot proceed from a nebulous planet or comet, revolving about the sun in an orbit either wholly interior to that of the earth, or wholly or partly exterior.

* Mr. Jones regards it as a specular reflection.—Eds.

This fourth proposition was not perhaps distinctly enunciated by Mr. Jones; but as it is sustained, equally with the others, by the observations, it is added, in order that the exclusion of all previous hypotheses may be complete; for if these four propositions be admitted, every conjecture which has hitherto been esteemed worthy of a moment's serious consideration, in regard to the source of the zodiacal light, is effectually cut off. No alternative seems to remain to us but to attribute the appearance to a ring surrounding the earth and illuminated by the sun.

But though the evidence in favor of this hypothesis is mainly negative, the writer has no disposition to deny that certain positive indications furnished by the observations seem to point in the same direction. To such, however, he attaches less importance than he might otherwise be disposed to attribute to them, for two reasons, viz., 1, they are in themselves so indecisive, that, but for the negative evidence, they would have little weight; and, 2, they are of a kind, of which, if the earth has really such a ring as is supposed, we ought to have many and conclusive examples, instead of occasional and doubtful ones. Upon this point it is proposed briefly to dwell, further on. In the mean time, a remark or two may be made in regard to the first of the foregoing propositions; in support of which the reasons assigned by Mr. Jones appear to be not quite satisfactory. According to him, if we are ourselves involved in a nebula, we can discover nothing in regard to its form—we can obtain no outline—and yet the zodiacal light presents to us a constant and distinct shape. This mode of reasoning would be very just, if applied to a cloud enveloping the observer so dense as to be capable of absorbing the light from its remoter parts before it could reach him; and it would be no less so of any nebula, dense or rare, which should be equally extended in all directions from the point of observation. But the case is evidently very different with a transparent body very limited in one dimension and very much extended in another. It is not necessary to assert that the apparent outline of such a body obtained by an observer immersed in it would be very sharp and well defined. It would probably not be so at all; but herein it would correspond very happily to the appearance of the zodiacal light; since nothing can be more uncertain or more difficult than the exact determination of the outward limits of this light, even when its central portions are brightest. The galaxy presents an admitted case, in which the observer obtains a pretty good outline of a nebula, and even of its ramifications, though himself immersed in it; and, in this instance, the sharpness of definition is, to most eyes, much superior to that of the zodiacal light. These considerations are presented without the design of attaching to them any very high importance; but because the hypothesis we are considering derives its plausibility

mainly from the want of plausibility in any other, and depends upon a series of exclusions, of which the very first in order is decidedly not established.

The evidence of the truth of his second proposition is found by Mr. Jones, in the fact that a zodiacal light was visible to him in the east and the west at the same time, when the sun was depressed ninety degrees below the horizon. That neither of these lights could have been reflected from a ring interior to the earth's orbit, is obvious.

The third proposition is regarded as established by the considerable changes which the lateral boundaries of the light undergo, as the position of the observer to the ecliptic is altered by the earth's diurnal motion; these changes being too great to spring from such a cause, if we refer the source of the light to a distance of more than 190,000,000 of miles, as we must do if we attribute it to a ring external to the earth's orbit. An argument more decisive than this, and to the same effect, would seem to be deducible from the fact that, if such were the source of the light, it ought to be vastly brighter in the quarter of the heavens opposite to the sun, than in that where it is in fact seen.

The *positive* evidence confirmatory of the truth of the hypothesis of a ring concentric with the earth, is embraced in these three facts:—

1. In low latitudes, the light is visible throughout the year.

2. To an observer who has the ecliptic vertical at midnight, the light appears both in the east and in the west, at the same time.

3. The moon appears occasionally to produce a zodiacal light.

Having thus stated the grounds on which the theory of the zodiacal light proposed by Mr. Jones rests, it is in order to consider the difficulties which this theory suggests. These are the following:

1. The aspect of the light itself is not such as a ring ought to present.

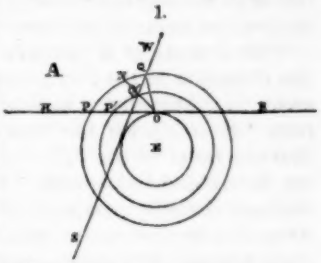
2. The axis of the light undergoes no parallactic displacement, however great be the observer's change of position; and the explanation offered of this difficulty by Mr. Jones is not satisfactory.

3. The geometrical inferences to which the hypothesis legitimately leads, as they are deduced from different observations are inconsistent with each other.

4. To adopt the supposition of a nebulous ring surrounding the earth in order to explain the phenomena which are actually observed, involves unavoidably a necessity that other still more striking phenomena should present themselves, which are *never* observed.

To explain more particularly what is intended by the first of these propositions, we may remark that the appearance of a ring

remote from the earth, and seen by reflection just previously to the morning, or at the close of the evening twilight, ought to present some characteristics which are wanting in the zodiacal light. That it is never visible in the quarter of the heavens opposite to the sun, may be attributed to the fact that it there falls into the shadow of the earth; but toward the sun its form should be unlike what it is. Considering it as limited by the shadow, we should expect that its upper portion should display a brightness gradually fading, (as it actually does,) but we certainly should not look to see this fading commence from the very horizon itself. If, in the annexed figure, E be the earth, SW the tangent limiting the shadow, HR the horizon, and PP′Q′Q the portion of a nebulous ring concentric with the earth visible to the observer at O, then the angle HOQ will measure the apparent altitude of the illumination, the point Q being the intersection of the tangent, SW, with the most distant stratum of the ring which is capable of reflecting light in sufficient force to impress the eye. The point Q′ will be the intersection of the same tangent with the nearest stratum of the ring. Within the angle Q′OQ will necessarily be observed a fading brightness, the maximum being at Q′, and the minimum, which is zero, at Q. But below Q′, and within the angle HOQ′, the brightness should be uniform, and the breadth also:—or if there be any difference, it should be in favor of the point Q′ in both these respects, on account of its greater proximity to the observer. This circumstance would make a very sensible difference, unless the ring were much more remote than any observations yet made justify us in placing it. If, in regard to the point of brightness, it be said that the line of vision OQ′N, at a determinate altitude above the horizon, would intersect the ring less obliquely than OP′P, in the horizon, and would therefore encounter a smaller number of illuminated particles than are met by the other, it may be said, on the other hand, that the horizontal ray is much more powerfully absorbed by our atmosphere than the other; so that the probability of the greater conspicuousness of the portion of the ring at Q′ is not seriously affected by the objection. Now we know that, at the very earliest moment at which we are able to observe this light after sunset, (which is the close of twilight,) the appearance presented is that of an uninterrupted diminution both of breadth and brightness, from the very horizon upward. There is certainly no limit, as at Q′, dividing a part, Q′P′, uniformly bright, or decreasing downward in brightness, from the



other part Q′Q, in which the brightness decreases upward. What then can we conclude, if we adopt the ring theory, but that the point Q′, where the tangent, SW, meets the lower surface of the ring, is itself in the horizon or below it? But at the close of twilight this same tangent (when the light happens to be in the vertical passing through the sun, as it is occasionally in low latitudes) intersects the upper stratum of the atmosphere precisely in the horizon; and hence, so far as the mere aspect of the light can furnish a basis of argument, we are forced to conclude, that if the brightness is a reflection from a body concentric with the earth, this body cannot be one having any sensible interval intervening between it and the atmosphere.*

The absence of a parallax appears, secondly, to furnish a serious objection to the ring theory. Mr. Jones's mode of explaining away this difficulty is ingenious, but it will hardly bear examination. He supposes the ring to have considerable breadth, and that the *locus* of the light (or more properly of its axis) is different for different observers; being in all cases in a plane passing through the eye, parallel to the ecliptic. Mr. Jones seems to look upon this as an optical necessity; but apparently without sufficient reason. In the first place, it is probable that the supposed nebulous ring, if visible at all, would be visible throughout its whole breadth, and would present no sensible lateral variation of brightness. Secondly, should such a body exhibit an axis of maximum brightness, this axis would not be of necessity, nor usually, parallel to the ecliptic. The case is by no means that of a cylindrically concave solid reflector. In that case, parallel rays at right angles to the axis of the cylinder, would undoubtedly be reflected to an observer within the curve, in a plane also perpendicular to the axis, and passing through his eye; and if the reflector were an imperfect one, there would be an elongated luminous *locus*. In the case of a transparent nebulous body, however, there is no such thing as a continuous reflecting surface; but each particle is an independent reflector, the intensity of the light which it throws to the eye being unaffected by the neighborhood of other particles, or by the general form which the entire group may possess; but varying only with the angle included between the incident and reflected rays. Of all the parallel rays falling upon the particles of such a group, that one will be most forcibly reflected to the observer, which after reflection, makes the largest angle with its incident direction. Accordingly, if the sun, being below the horizon, but near it, illuminate a nebulous mass of uniform thickness or depth (in the direction of vision) it is manifest that, of any row of particles in that mass taken horizontally,

* This argument does not suppose the reflection specular, as Mr. Jones claims—a kind of reflection which requires a polished surface to the particles of the nebula. —Eds.

the brightest (so far as there is a difference) will be that which is in the vertical passing through the sun; and, therefore, that, if the nebula is extensive enough, this same vertical plane, by its intersection with the nebula, will determine the *locus* of principal brightness. It can rarely happen, however, that the ecliptic will pass through the observer's zenith; and when it happens, the state of things can be but momentary. The fact therefore, that the axis of the zodiacal light appears to be always in the ecliptic, and that it is not displaced laterally by any change of position in the observer, appears to the writer to furnish a proof almost decisive that this light cannot proceed from a nebulous ring encircling the earth.

In admitting, in the foregoing argument, the possibility that the light reflected to a nebulous body may have an axis of maximum apparent brightness, it will be observed that the admission rests upon the supposition that, in a certain plane, the angle between the incident and reflected rays will be maximum. This, however, can only occur with parallel incident rays so long as this angle exceeds ninety degrees. When the same angle is less than ninety, this central plane will be the plane of minimum intensity, instead of maximum; and therefore, if a nebulous ring surrounding the earth, should be illuminated in the portions above the horizon when the sun is ninety degrees below, it is impossible that its brightness should be restricted to a limited portion of its breadth. Yet the delineations of the zodiacal light, as observed under these circumstances, in Mr. Jones's diagrams, presented no peculiarity—certainly no enlargement of breadth. We can form no other conclusion, therefore, but that the nebulous body from which this light proceeds, is always seen illuminated throughout its whole extent; and consequently that the absence of a parallax is inadequately accounted for by the explanation suggested by Mr. Jones.

The foregoing observations in regard to the appearances which an illuminated nebula may be expected to present, are confirmed by the actual phenomena of twilight. When the sun is very near the horizon, the point where he is about to rise is marked by a greater degree of brightness than any other; but this brightness is not restricted within very narrow limits, nor is it wholly owing to more intense reflection, but in a measure to the greater depth (in the direction of vision) of the mass of air illuminated. At a distance so far from the sun that the reflected rays come to us making with the incident an angle less than ninety degrees, or not much greater, the sky is uniformly bright in every direction. And when the sun has sunk so low as only to illuminate the borders of the western horizon, we observe no greater inequality of brightness throughout the whole extent of the illumination, than is fairly attributable to the varying depth of the mass illuminated.

Mr. Jones himself furnishes an argument almost conclusive in disproof of the hypothesis of an illumination merely local, in his record of the aspect of the light as it appeared, on one or two occasions, in presence of the moon. He considers it to be well established that the ring was made visible by a reflection of the moon's light; or at least that its visibility was partially due to that cause. He attaches particular importance to one of these observations, because the moon was, at the time, *without* the boundaries of the light. Yet if the sun produces a luminous *locus*, there is no reason why the moon should not do the same; and it is obvious that the two *loci*, under the circumstances just described, could not possibly be coincident. On the other hand, the fact that the moon illuminated the ring in a line not passing through, but passing *by* itself, would seem to demonstrate pretty conclusively that the nearer margin of the brightness was the actual boundary of the ring. The circumstances must have been peculiarly favorable which brought the moveable reflection of the sun's light at the same time, upon the same margin also.

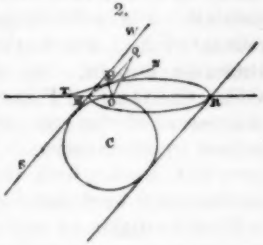
Upon this point there remains to be added but a single further observation. If the zodiacal light is but a luminous *locus*, shifting its place as the observer moves, and occupying but a limited portion of a broad nebulous ring, then either this light should be more or less visible at all seasons and in all latitudes when the sun is below but near the horizon (and more conspicuously so in proportion as the ring is more distant from the earth) or at certain inclinations of the ecliptic to the vertical, it should grow narrower by losing a portion of its breadth on one side only, and should thus disappear by a gradual extinction proceeding from side to side. The first of these cases corresponds to that of a ring having a breadth at least equal to the earth's diameter; the second supposes the breadth to be less than this diameter; and the inclination of the ecliptic which should cause the axis of the brightness to pass off from the ring may be found by the equation,

$$\text{sin. zenith dist. of ecliptic} = \frac{\frac{1}{2}\text{ breadth of ring}}{\text{earth's radius}}.$$

These propositions which, if no lateral parallax is admitted, would represent rigidly the truth in regard to a nebulous ring concentric with the earth, are believed not either of them to hold of the zodiacal light.

The third source of difficulty in regard to the ring theory is found in the inconsistency of the results legitimately deduced from different observations. Assuming the theory to be true, the place of the summit of the light when visible must be determined by the intersection of the uppermost strata of the ring with

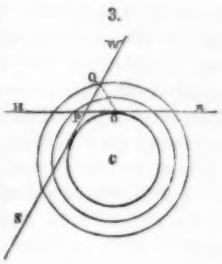
the earth's shadow. The axis of the light being also visibly parallel to the ecliptic, we need but a single observation of the zenith distance of the summit to enable us, with a knowledge of our latitude and the sun's hour angle and place in the ecliptic, to determine the distance in miles. A general method for this purpose may be sketched out as follows:



The intersection of the horizon with the conical shadow of the earth is an ellipse, of which, according to a well known and general property of conic sections, the point of contact with the earth, or the observer's place, is a focus. Now if, to an observer at O, the centre of the light at its base be in the direction OP, and the summit in the direction OQ, then the plane OPQ intersects the convex surface of the shadow in a line sensibly straight, PQ. If we regard the shadow as a cylinder—as for the purposes of this inquiry we may do without appreciable error, PQ will be truly straight and parallel to the axis of the shadow.

The latitude and the hour angle enable us to find the sun's depression below the horizon, which is the measure of the inclination to the horizon of the axis of the shadow, which we may represent by the letter I. If we put D for the earth's diameter, then the major axis, HR, of the ellipse, will be equal to D×*cosec.* I, and the minor axis will be D itself.

The sun's place in the ecliptic, combined with the data above mentioned, will give the difference of azimuth of the point P and the sun, or the angle HOP, and the inclination of the plane OPQ to the horizon. The observed vertical altitude of Q, combined with this last, will give the angle POQ. The axes of the ellipse and the azimuthal angle HOP enable us to determine the length of the focal radius, OP. From the same azimuthal angle and the angle I, we deduce the inclination to the horizon also of a plane touching the cylinder in PQ, of which TN is the trace; and also the angle QPN. Then, at P, we have a solid angle contained by the tangent plane just mentioned, the plane of the horizon and the plane OPQ, in which one of the containing plane angles and two of the inclinations are known. Hence we derive the plane angle QPO, giving, us finally, in the triangle OPQ, two angles and a side, from which OQ is ascertained; and of this the inclination to the horizon has been found by observation. The distance of the point Q from the centre of the earth is therefore determined, and consequently the altitude of the superior stratum of the ring.



The process is however greatly simplified, if we make the observation from a station where the ecliptic happens to be vertical when the light is in view. Let OQP be a vertical plane, PQ being apparently in the axis of the light and Q the summit. PO is the tangent (to the earth's radius) of half the sun's depression, and is therefore known. In the plane triangle OPQ, the angle at P is equal to the entire depression of the sun, and POQ is determined by observation. These, with the known base, OP, will give OQ, from which the height of the ring above the earth's surface may be determined as before.

Now to make an application of this method, not with a view to obtain a result perfectly accurate, for which no observations sufficiently precise are at hand, but in order to find an *outside limit* to the possible altitude of the visible ring; it is safe to assume that the luminosity has never been seen extending more than seventy degrees vertically upward, even when observed immediately after the disappearance of evening twilight. The writer has never had an opportunity of seeing the light perfectly at right angles with the horizon, though he has often seen it nearly so; and its utmost extent has never appeared to him to exceed sixty degrees. But a calculation based upon the data just stated, viz., that, with the sun 18° depresssed, the angular altitude of the luminous column when at right angles to the horizon is 70°, gives us but 186 miles as the extreme height of the superior portions of the ring above the surface of the earth:—a height which is increased only to 204 miles, if we assume, what is believed to have never yet been observed, that the light may reach from the horizon entirely to the zenith.

This result gives us, it must be confessed, but a mean opinion of the magnificence of "the earth's ring." Yet there is little doubt that it is even more favorable in respect to dimensions, than could be deduced, by the help of the same mathematical method, from most of the observations hitherto made of this phenomenon, whether by Mr. Jones or by any other observer. The probability is that the results of such an examination would all be more or less discordant with each other; while it is manifest that, in a few instances, we should reach conclusions singularly at variance with the mass. Mr. Jones several times observed the light simultaneously in the east and west horizons, when the sun was depressed ninety degrees. The two columns continued to be both visible for the space of two hours. They must consequently, at midnight, have had considerable altitude—as in fact his diagrams proved, although the measured height, if it was stated by him,

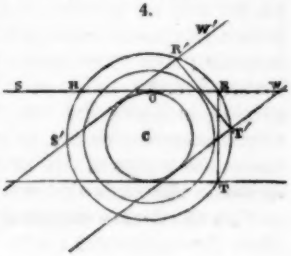
is not remembered. Now had the light been at that hour but barely perceptible in the horizon, it is manifest that the intersection of the tangent limiting the earth's shadow with the outer stratum of the ring, could not have been below the horizon. Supposing then that intersection to have been situated exactly at the horizon, its distance from the earth's centre would be equal, in miles, to $3956\sqrt{2}$, or 5596:—giving a distance above the earth's surface of 1640 miles. Supposing the angular altitude of the light at the same time to have been thirty degrees, the distance of the apparent summit from the earth's surface must have been 3434 miles, or nearly equal to a radius of the earth; and allowing it to have been forty-five degrees, the same distance would have been 4890 miles.

The singular discrepancies to which the different observations conduct us, lead us almost irresistibly to the conclusion that the ring hypothesis is untenable. They cannot be explained but by making assumptions in regard to the reflecting power of the nebulosity, such as to destroy the value of all observations upon this phenomenon, and to conflict, at the same time, with established laws of optics.

But, in the fourth place, in accepting the hypothesis of a ring, we must accept along with it, not merely those consequences which it may be convenient to us to admit, but all the consequences which it legitimately involves. We must show that the visible arch which we regard as a portion of this supposed ring, conforms, under all circumstances, to the geometrical conditions which the hypothesis imposes. That we may be able to judge how far this is the case, let us consider how these conditions may be investigated.

Suppose a spherical surface to be generated by the revolution of the ring about the line which joins the centres of the earth and sun, and which, being produced, forms the axis of the shadow. In this spherical surface the ring must always be found, being subject only to the condition that one of its diameters shall coincide with this line which we have assumed as the axis of revolution. The intersection of the shadow of the earth (considered for the present purpose as cylindrical) with the same spherical surface, will be a small circle of the sphere; and the intersection of the plane of the horizon will be another small circle. Assume the position of the sun to be ninety degrees from the zenith of the observer, and it will be at once self-evident that the arc-radius of one of these small circles will be complementary to that of the other. If, in the figure, HR be the projection of the circle of the horizon and RT,

4.



or R′ T′, that of the circle of the shadow, it is plain that the extremities of the illuminated arch will always be found in the circumference RT, or R′T′; but the question of the visibility of either of these extremities will depend on the relation of the plane of the ring to that of the horizon. For convenience, let the circle RT be called the limit of illumination, or more briefly, the limiting circle; and in order as much as possible to simplify the illustration, let the sun be supposed to be in the equinox, and the observer at the equator. At the moment of sunset, the limiting circle will be in contact with the other by its upper or preceding limb. As the sun sinks, the circles will intersect; and in what follows, we may distinguish three cases, according as the limiting circle is equal to, less, or greater than, the circle of the horizon. If the two circles are equal, the intersection will continue until the sun's depression becomes 90°, when the planes of the circles will coincide. During all this time it is possible that one of the illuminated cusps of the ring may be above the observer's horizon, and therefore in a situation to be seen. There is, in fact, but one position which can possibly be given to the ring, by which it may be kept wholly invisible; and that is, a position at right angles to the equator, which in the case in hand is excluded by the condition that the plane of the ring shall coincide with the ecliptic. Only one cusp, however can, in this case, ever be seen at a time; but as the first cusp disappears at midnight, the second one will immediately make its appearance, and continue to be visible until dawn. At the moment of sunrise, the limiting circle will touch the horizon again, but will make the contact, this time, by its following limb.

If the limiting circle be less than the circle of the horizon, then the sun descending as before may bring into view one of the cusps immediately; and in a right sphere it would do so, though not necessarily in an oblique one. When the centre of the limiting circle, however, reaches the horizon, one of the cusps must appear, whatever be the observer's latitude; and both of them may do so. But the appearance of the second is not a matter of necessity until the limiting circle touches the horizon by its following limb. At the depression of 90°, the planes of the two circles will be parallel, and the two cusps will be equal; after which the preceding one will diminish and the following one will increase; the phenomena preceding the dawn corresponding in inverted order to those which followed the twilight. The observations made by Mr. Jones of the two luminous columns simultaneously visible at midnight would indicate that, if they were the cusps of an interrupted ring, the case which actually exists in nature is that which is here described.

The third case supposes the limit of illumination to be greater than the horizontal circle. In this case, the intersection of the

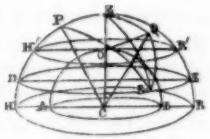
planes begins, as before, at the setting of the sun, and continues until the preceding limb of the limiting circle touches the limb of the horizontal circle opposite to its first point of contact. During this period, one cusp may possibly be visible, and in a right sphere probably would be. But after this second contact, neither could be seen until after midnight, the following limb of the limiting circle should touch the horizon at the original point of contact, when the second cusp might in its turn become visible. In this case, it is not matter of necessity that the light should be seen at all during the sun's absence; nor that, when seen, it should extend over an enormous arc of the heavens; and in these two particulars it best corresponds to the facts of ordinary observation.

Now in order to discuss the necessary aspects of the ring under definite conditions, it is to be observed, that we have, upon the surface of our imaginary sphere, two fixed points, the zenith and the pole of diurnal rotation; and two moveable ones, the pole of the limiting circle (which is the centre of the earth's shadow), and the extremity of the illuminated arch. By the aid of these, when the latitude is known, the sun's depression below the horizon given, and the arc-radii of the limiting circle and of the circle of the horizon determined by assuming any distance for the ring from the earth's centre which the observations may seem to warrant, we may ascertain what circumstances, if any, will limit the visibility of the light, what ought at any time, to be the apparent extent of the illuminated arch, what should be its apparent altitude above the horizon, within what limits of latitude it ought always to be visible in both the morning and the evening sky, and within what it should be seen either in the morning or the evening, with various other particulars which may serve to assist in determining how far the light as actually observed fulfills all the conditions of a ring surrounding the earth. The discussion may be pursued on the supposition either that the ring has a parallax or that it has not. In the first case, if the ring could be supposed as remote as the moon, or nearly so, the indefiniteness of its outlines would probably render it somewhat difficult to detect the parallax, though real; and we might proceed with our discussion, at least for the purposes at present in view, as if no such parallax existed. But if, on the other hand, we find ourselves compelled (as, from what has already been said, it is evident that we are,) to limit the distance to one or two of the earth's radii from the centre, then the effect of parallax will be enormous; and the ring, though really lying in the plane of the ecliptic, can never appear to be so, except when vertical.

Let us, for example, assume, in the first instance, that moderate distance to which we have seen that the ordinary observations would lead us—that is to say, a distance not exceeding two

hundred miles; or as, under a favorable supposition, we have determined it, 186 miles above the earth's surface. The arc-radius of the circle of the horizon would in this case be 17° 14′; and that of the limiting circle 72° 46′. Now, as the zodiacal light is always most conspicuous just after twilight, or just before the dawn, let us assume the depression of the sun to be 18° below the horizon. The centre of the shadow, which is the pole of the limiting circle, will be equally elevated. In the figure, AOB is the earth, O being the place of the observer.

5.

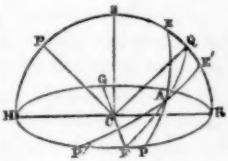


HR is the rational, and H′R′, the sensible horizon. HZR is the imaginary concentric sphere, generated by the revolution of the ring, and P is the pole of diurnal rotation. S is the point opposite the sun, or the pole of the limiting circle, which must always be somewhere in the circumference of a small circle, DE, parallel to the horizon, HR, and distant from it by an arc equal to the sun's depression. Now if Q be taken as the extremity of the light, any where upon the circumference of the limiting circle (not drawn) of which S is the pole, the four points involved in our discussion are P, Q, S, and Z. ZS is the complement of the depression of the sun; PS is the co-declination; ZP, the co-latitude; and SQ, the arc-radius of the limiting circle. SQ being in the plane of the ecliptic, the sun's place in longitude will furnish the means of determining the angle PSQ; and the depression will enable us to find PSZ: consequently, ZSQ, or the angle made by the ecliptic with the vertical passing through the sun will become known. Consequently ZQ, which is the zenith distance of the cusp, as seen from the centre, C, will be ascertained. By reduction to the surface, O, we shall obtain the apparent direction of the light.

If we now assume the point Q to be somewhere upon the circumference of the small circle, H′R′, we shall be able to find what is the maximum angle, ZSQ, made by the ring with the vertical, at which the cusp can be seen by the observer at O. And comparing this with the angle made, at different seasons, by the ecliptic with the vertical, at the assumed depression of the sun, we can determine the various aspects which the light ought to assume. Taking, for example, the latitude of Oxford, Mississippi, which may be roughly stated at 34° 30′, it will appear that the summit of the light ought to be in the horizon, when the angle between the ecliptic and the vertical passing through the sun, at the close of twilight, is 18° 4′; and also that the point where the summit is last seen, is distant from the sun, in azimuth, more than 90°. The ecliptic will at this time have an apparent inclination of 17° 9′ to the vertical drawn to its setting point, and this point will differ from the sun in azimuth less than six degrees.

If we take the season when, at the close of twilight, the ecliptic makes the largest angle with the horizon—that is to say, when the vernal equinox is in the western horizon at that moment—the apparent altitude of the extremity of the light should be less than eight degrees*, and this extremity should be 90° distant in azimuth from the sun, while the base should be distant about 42°, making the length of the luminosity, about 48°. Its apparent inclination to the horizon should be 19½ degrees. The ecliptic, in the mean time, will have an apparent inclination of 79° to the horizon, and its setting point will be distant in azimuth from the sun less than four degrees. Upon the supposition we are now considering, the zodiacal light should never be seen in the evening sky in the winter, until the close of January, and it would reach its maximum conspicuousness during the first week in March. It would be too faint however, to be noticeable until probably the middle of February, or later, so that its sensible duration would be but a few weeks.

6.



* That the minimum inclination of the ecliptic to the horizon will occur when the autumnal equinox is setting, and the maximum, when the setting point is the vernal equinox, is perhaps sufficiently evident to require no demonstration. It may be established, however, as follows: If HPR be the western horizon; P, the pole; FAQ, the equator, and Z the zenith: then, if PAE represent the ecliptic intersecting the meridian at E, the equator at A, and the horizon at P, A will be the vernal equinox. Also, the triangle, EPR, will be right angled at R, and the angle at P will be the inclination of the ecliptic to the horizon. ER will be the altitude, and EZ the zenith distance, if the culminating point of the ecliptic. Then,

Cos inclination (EPR) = cos ER × sin PER = sin EZ × sin PER. But ZE = ZQ − EQ = latitude minus the declination of the culminating point of the ecliptic. Put I = inclination, L = latitude, D = declination EQ, and E = angle PER; then,

$$\cos I = \sin (L - D) \sin E.$$

And if declination south be regarded as negative, the same formula will express equally the inclination for the position P′E′ of the ecliptic, when A is the autumnal equinox.

But, $\sin (L - D) = \sin L \cos D - \cos L \sin D$; whence

$$\cos I = \sin L \cos D \sin E - \cos L \sin D \sin E.$$

But, in the triangle AEQ, cos D sin E = cos EAQ (= obliquity of the ecliptic), which put = O; and sin D sin E = sin EAQ sin AQ (= right ascension of the culminating point of the ecliptic), which put = A. Then,

$$\cos I = \sin L \cos O - \cos L \sin O \sin A,$$

in which the only variable is A, the right ascension of the culminating point of the ecliptic.

It is manifest that cos I is least, and I greatest, when sin A is at its positive maximum—that is to say, when the R. A. of the point of the ecliptic on the meridian is 90°. In like manner, cos I is greatest, and I least, when sin A is at its negative maximum; or when the R. A. of the same point of the ecliptic is 270°. But in the former case the vernal equinox is on the western horizon, and in the latter the autumnal.

The foregoing formula furnishes a convenient means of ascertaining at what season the ecliptic will have a given inclination to the horizon at a given hour of the day or night; and thus to determine between what limits of time a phenomenon will be observable, whose visibility depends on this inclination. Such an application is made of it a little further on; and it is on this account, and not so much for the sake of the proposition directly demonstrated, that it is introduced here.

It is hardly necessary to point out how entirely different are these results from the facts of observation. If, on the other hand, we suppose the light to be a mere *locus* of brightness, moveable laterally with the observer, then in this latitude, it should never be invisible either in the morning or in the evening sky:—at least, it should never be invisible unless the breadth of the nebulous ring is less than $2\times3956\times\sin 58^\circ$, ($58^\circ$ being the greatest zenith distance of the nonagesimal in this latitude). Its length, when most reduced, ought to exceed 50°, (supposing it to be 70° when vertical, which is the supposition on which the distance was determined,) and consequently it either ought to be very conspicuous always, or it ought to become extinct by growing very gradually narrower and narrower for many days or weeks, without losing in length,—a process which should be very observable, but which yet has never been observed.

One further consideration remains to be added. Whatever may be thought of the probability in regard to a lateral parallax in a case of this kind, no one would think of questioning the fact of a parallax in a longitudinal direction. Now the duration of this phenomenon in the evening sky is entirely too great to be consistent with the supposition that its source is so near to us. If the arc-radius of our horizontal circle is only $17^\circ\ 14'$, then the preceding limb of the limiting circle will, at the close of twilight, have passed the zenith by $46'$; and it will have to advance but $17^\circ\ 14'-46'=16^\circ\ 28'$, in order to pass off from the horizontal circle entirely. The total duration of the phenomenon, therefore, up to the vanishing of the last trace of light, should be less than the duration of the preceding twilight—which, in this latitude is in the early part of March, less than an hour and a half. If we consider also that, long before it should entirely set, it would become inconspicuous and probably hardly visible, we shall see that it ought sensibly to disappear very soon after first presenting itself in the evening sky, instead of seeming to partake, as it does, in its descent, of the general motion of the heavens.

It may be said, however, that we ought not to rest our reasonings upon an assumption of so inconsiderable a distance for the ring; since its visibility at midnight, and with the sun depressed 90°, demonstrates that it must be more distant. I am willing to take the largest distance that can be adduced from any observations; or even a *larger* distance than would be required to satisfy any. We have seen that, if the light were visible in both horizons at midnight, with a vertical altitude of 45°, it would conduct us to a distance of less than 5000 miles above the earth's surface. Suppose therefore that we adopt 9000 miles as the radius of the ring, or rather, that of its highest visible stratum. The consequence, if in a few particulars more favorable to the hy-

pothesis than before, will in many others, conflict with it even more violently.

It is totally impossible, in short, to admit that the ring can be seen at all at midnight, without being forced to require that it *shall* be seen spanning an immense arch in the heavens, earlier or later in the night. Suppose, for instance, that at the time of the midnight observations of the zodiacal light by Mr. Jones, when the columns appeared in his prime vertical and equal to each other, there had been an indefinite number of observers posted along the great circle of the earth which was coincident at the moment in plane with the ecliptic; all of them, therefore, having the ecliptic vertical. We must be permitted to take it for granted that the luminous columns visible to Mr. Jones would also have been visible to every other such observer, whose horizon did not pass above the illuminated substance whatever it may be, on the one hand, nor approach so near to the sun as to be affected by his light, on the other. And consequently the eastern column must have appeared more extended, to observers east, and the western, to observers west, than they did to Mr. Jones. Now if we take an observer among this number, to whom the sun was but 18° depressed, and assume that the light produced from a ring interrupted by the earth's shadow, and (in the first instance) presenting to one in the position of Mr. Jones, only a trace of brightness in the east and west horizons, then this supposed observer of ours must have seen the light stretching 158° from the horizon on the side of the sun through his zenith, and therefore to a point only 22° above the opposite horizon.

The ecliptic is only vertical in the inter-tropical regions, and I remember no records of the phases of the zodiacal light in those latitudes, made earlier than those of Mr. Jones. Though I have not had the opportunity of examining his diagrams particularly, I think I am correct in presuming that he has recorded no aspect of the light, in which it seemed to pass the zenith. In the latitude of Tuscaloosa, Alabama (33¼°), I have often observed the light when the ecliptic passed within 10° of the zenith, and when the effect of inclination would not have been to reduce the length of the column a single degree; yet I never saw the summit of the brightness approach anywhere near to the meridian.

If we make the radius of the supposed ring 9000 miles, then the maximum apparent length of the arch will exceed 160°, or approach within less than 20° of the opposite horizon. To follow out with greater particularity the consequences of this supposition, we observe that it will make the arc-radius of the circle of the horizon very nearly 64°, and that of the limiting circle, 26°. Assuming that the light is not a mere luminous *locus*, moveable laterally, we shall find that it must always be visible

at the close of twilight, so long as the angle between the ecliptic and the vertical passing through the sun is less than 67° 26′; which, the sun being depressed 18°, will make the minimum inclination of the ecliptic to the horizon, at which it can be seen, 28° 34′. Now as the minimum inclination of the ecliptic to the horizon in any latitude (which occurs in the northern hemisphere when the autumnal equinox is on the western horizon) is evidently equal to the co-latitude diminished by the obliquity of the ecliptic to the equator, we may easily ascertain within what limits of latitude the light ought never to be absent from either the evening or the morning sky. For this purpose we have the equation,

$$\text{Co-lat.} - \text{obliq.} = 28^\circ\ 34'.$$

Whence Co-lat.$=52^\circ\ 2'$, and Lat.$=37^\circ\ 58'$, or 38° nearly.

At Tusealoosa, however, which is considerably within this limit, the zodiacal light is very far from being constantly present.

Similar considerations enable us to find a limit beyond which the supposed ring can never be visible. This is obtained from the equation,

$$\text{Co-lat.} + \text{obliq.} = 28^\circ\ 34'.$$

Whence, Co-lat.$=5^\circ\ 6'$ and Lat.$=84^\circ\ 56'$, or 85° nearly.

Thus, in favorable positions of the ecliptic, the light should be seen in any latitude not within 5° of the pole.

In the latitude of Oxford, say 34° 30′, the minimum inclination of the ecliptic to the horizon is about 32°. The ecliptic will have this position at the close of twilight, when the sun's longitude is about 144° 20′, the autumnal equinox being in the western horizon at its intersection with the prime vertical. The ecliptic will be inclined 58° to the prime vertical, and 63° to the vertical passing through the sun. These conditions enable us to determine, that under the circumstances least favorable to its visibility, the zodiacal light in this latitude should stretch along the horizon more than 71°, its base being distant from the sun in azimuth nearly 83°, and the extremity reaching to a distance in azimuth from the sun of 154°. The extremity would be elevated only about $1\frac{3}{4}^\circ$, but the middle portion of the arch would approach 6° of altitude. The arch, however, could not be a circle of the sphere, but a spherical conic section. This would be the state of things at the close of twilight, about the end of August, if the light were a reflection from such a ring as we have supposed. We should therefore, at this season and at this hour of the evening, see a brightness in the south and south-east extending nearly a quadrant along the horizon; but rapidly rising and passing over to the west as a greatly inclined pyramid, and finally disappearing, about half an hour after midnight, at a point some 35° from the southern point of the horizon.

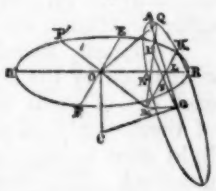
But about $2\frac{1}{2}$ hours before midnight, the other branch should appear. Its apparent length at midnight should be 72°, and the apparent altitude of its summit 21°. At dawn, this arch should have attained a length of more than 108°, and an altitude approaching 66° at its middle point, its inclination to the horizon being about $62\frac{1}{2}$°. Its base should be 26° south of the east point, and $57\frac{1}{2}$° distant in azimuth from the sun. It is evident, therefore, that on this supposition, the light would usually be very far apparently from the ecliptic.

Nor will the case be much improved, if we suppose no lateral parallax to exist; for though, by this means, we may reduce the apparent place of the phenomenon to that in which it is actually observed, by so doing we shall only render the discrepancy between theory and observation, in regard to the conspicuousness and magnitude of the phases, more striking. To investigate this case geometrically, we must suppose a plane passing through the observer's eye, and parallel to the ecliptic, to intersect our imaginary sphere. The intersection will mark the locus of the light. But, if the ring is to be regarded as a hollow cylinder, then as, in the new position of the luminosity, it is a small circle of the sphere, we should, if we aimed at extreme accuracy, increase the radius according to the formula,

$$R = \sqrt{9000^2 + 3956 \cdot \sin Z D^2},$$

in which R is the radius of our imaginary sphere concentric with the earth; Z D is the zenith distance of the nonagesimal; 9000, the radius heretofore assumed; and 3956 the radius of the earth. With this new value of R, we should calculate again the arc-radii of our two circles of limitation and of the horizon. As, however, the radius already assumed is larger than any which can be deduced geometrically from any observation, and as the error resulting from a neglect of the correction is not in favor of the views taken in this paper, the inquiry will not be unnecessarily complicated by taking account of this circumstance.

7.



In the annexed figure HERF is the circle of the horizon; AKBN, the limiting circle, and P′PMQ the plane of a circle parallel to the ecliptic (of which the circumference is not drawn). Q is the summit of the luminosity, and OQ is the line of its apparent direction from the observer. From the latitude, the sun's place in the ecliptic, and his depression below the horizon, we have no difficulty in finding the angle HOP′, and the inclination of the plane P′OPMQ to the horizon. The inclination of the plane AKBN is equal to the complement of the de-

pression, and the angle OML is the complement of HOP′. O being the centre of the circle of the horizon, and G that of the limiting circle, the depression enables us to find OL, GL. ML = OL . tan MOL; and $GM = \sqrt{GL^2 + ML^2}$. Also, angle GML is easily found. Now the three planes make a solid angle at M, of which one of the containing plane angles (OML) is known, and also two of the inclinations; whence the angles QMO and QML may be ascertained. Also, GMQ=GML+LMQ: consequently, if a perpendicular, GL′, be dropped from G on MQ, its length may be found, and also the ordinate QL′, and the line L′M: whence QM is known. OM is found in the triangle OLM: and therefore, in the plane triangle OMQ, we have OM, MQ and the angle OMQ, from which to obtain the angle MOQ. This, and the known inclination of the plane OMQ to the horizon, enable us to determine the apparent altitude of Q.

This method has been applied to determine the aspect of the light as it would, under this supposition, appear in this latitude, at the close of twilight, when the inclination of the ecliptic to the horizon is at its minimum. The arch would follow the course of the ecliptic, from a point on the horizon 31° 20′ distant in azimuth from the vertical passing through the sun, one hundred and forty-one degrees. The highest point of the arch would be 32° above the horizon, and the extremity of the light would have an apparent altitude of 19½°. There would also be a trace of the opposite cusp, rising about 2½° from the horizon. This being the appearance under the circumstances least favorable to visibility, at all other times both cusps ought to be seen, both morning and evening, throughout the year; and one of them ought always to have an enormous length when the sun is within 18° of the horizon.

These results being optical and geometrical necessities consequent upon the hypothesis of a nebulous ring surrounding the earth and illuminated by the sun's light, and being all of them unconfirmed by observation, it seems impossible to arrive at any other conclusion but that the hypothesis is untenable.

We appear, therefore, to be conducted to one and the same conclusion by the application to this theory of four distinct tests; each one of them having no slight independent weight, and all of them combined possessing an irresistible force. The zodiacal light must consequently be regarded as presenting a problem still unsolved. The observations of Mr. Jones, when published, may possibly present some clew to the mystery which has not yet been detected in them. But whatever else they may show, the present writer cannot but believe that they will furnish, in them-

selves, most conclusive proof, that the luminosity does not reside in any substance physically connected with the earth.

Upon the whole, whatever difficulties may attend the theory which regards the zodiacal light as having its seat in some appendage of the sun, there seems to be as yet no other supposition possessed of greater plausibility.

University of Mississippi, Oxford, Oct. 30, 1855.

ART. XXVII.—*On the Recent Eruption of Mauna Loa;* by Rev. T. COAN.*

IT is now ninety-seven days since the great valve opened on the mountain, and still the volcano works with unabated energy, pouring out its floods of fire in ceaseless torrents. Long ago we had expected to witness the molten sea sweeping over our fields, choking our harbor, driving our ships from their moorings and our citizens from their homes. But though the igneous flood still approaches us, its approach is *so slow* that our fears are greatly allayed. Reasoning mathematically, and assuming that the high fountain remain in force, the future terminus of the stream must be the seas; thus it is only a question of *time.*

After returning from the mountain, and having rested and attended to necessary duties, I determined to cut through the jungle to the lower end of the stream. Several natives had been up and reported the fire as making its way toward us, like the dogged and slow approaches of the allies before Sevastopol; but no white man had penetrated the jungle. On the 31st of October Mr. Ritson, an English gentleman, and myself, with three natives, entered "the bush," and beat our way through mud and jungle, until we came to a large and rapid tributary of the stream called Wailuku. Up this stream we wended our way with incredible toil, wading for miles together in water from one to three feet deep and along an uneven bottom of slippery stones, crossing and recrossing scores of times, to avoid rapids, deep basins and cataracts, slipping, falling, and plunging along, and when reaching an impassable basin, rapid, or precipice, crawling up the bank and beating slowly through the wet and entangled jungle, until the obstructions in the stream were passed, and then tumbling down again into its tortuous bed. Thus we urged our toilsome way under a drenching and continuous rain, at the rate of from one half a mile to one or two miles an hour, as obstacles were more or less serious.

* From a letter to Rev. C. S. Lyman, dated Hilo, Nov. 16, 1855. This account is in continuation of that published in the last number, page 139.

So soon as we entered this stream we found it discolored with pyroligneous acid from burning wood, whose odor and taste became more and more positive the farther we advanced up the stream. The discoloration also became more apparent as we proceeded, until the water was almost black. This showed that the lava flow had crossed the head waters of the stream and its small tributaries, consuming the forest and jungle, and sending down what could not be evaporated of the juices to mingle with the stream.

A little before sundown, our guide led us at right angles from the stream we had been threading for six hours, and in a few minutes the fires of the volcano glared upon us through the woods. We were within six rods of the awful flood which was moving sullenly along on its mission towards Hilo. The scene beggared description, and for a moment we stood mute and motionless. Soon, however, we moved on to the verge of the igneous river. Thrusting our poles into the fusion, we stirred it and dipped it up like pitch, taking out the boiling mass and cooling all the specimens we desired. We were on the right or southern verge of the stream, and we also found that we were about two miles above its terminus, where it was glowing with intense radiance and pushing its molten flood into the dense forest which still disputed its passage to the sea.

We judged the stream to be two or three miles wide at this point, and over all this expanse, and far as the eye could see above, and down to the end of the river, the whole surface was dotted with countless fires, both mineral and vegetable. Immense trees which had stood for hours, or for a day, in this molten sea were falling before and below us, while the trunks of those previously prostrated were burning in great numbers upon the surface of the lava. It is impossible to give you any just conception of the scene.

You are aware that the great fire-vent on the mountain discharges its floods of incandescent minerals into a subterranean pipe which extends, at the depth of from 50 to 200 feet, down the side of the mountain. Under this arched passage the boiling fusion hurries down with awful speed until it reaches the plains below. Here the fusion spreads out under a black surface of hardened lava some six or eight miles wide, depositing immense masses which stiffen and harden on the way. Channels, however, winding under this scorified stratum, conduct portions of the fusion down to the terminus of the stream, some 65 miles from its high fountain. Here it pushes out from under its mural arch, exhibiting a fiery glow, across the whole breadth of the stream. Where the ground is not steep and where the obstructions from trees, jungle, depressions, etc., are numerous, the progress is very slow, say one mile a week.

On the evening of our arrival we encamped within ten feet of the flowing lava, and, as before stated, on the southern margin of the stream, some two miles above its extreme lower points. Here, under a large tree, and on a bank elevated some three feet above the igneous flood which moved before us, we kept vigils until morning. During the whole night the scene was indescribably brilliant and terribly sublime. The greater portion of the vast area before us was of ebon blackness, and consisted of the hardened or smouldering flood which had been thrown out and deposited here in a depth of from ten feet to one hundred.

Not only was the lava, as aforesaid, gushing out at the end of this layer, but also at its sides. These lateral gushings came out before and behind us, and two-thirds surrounded our camp during the night, so that in the morning, when we decamped, the fusion was just five feet, by measurement, in front of us, six feet in our rear, and three feet, or the diameter of the trunk of our camp-tree, on our left. The drenching rain and our chilled condition induced us to keep as near the fire as we could bear it. Evening and morning we boiled our tea-kettle and fried our ham upon the melted lavas, and when we left, our sheltering tree was on fire. A large tree fell within ten feet of us during the night. Often, too, would the dried vines, parasites and leaves of immense trees take fire and running up to the height of seventy or eighty feet, throw off countless scintillations which sparkled and glanced amidst the gloom like myriads of fire-flies. But another exhibition exceeded all the rest in interest. At thousands of points on the solidified crust of the stream, the accumulating fusion, fed from above, was swelling and raising this superincumbent stratum into tumuli of endless form and size, and then, bursting open the cone or dome thus raised, either laterally or at the apex, when flowing off for several rods over the old substratum, the stiffening flood became solid. Soon, perhaps, another layer is spread upon this, and thus on indefinitely, until thirty or forty strata may be deposited in succession, raising the whole from a few feet to fifty or one hundred in thickness, and presenting a heaving surface like an agitated sea suddenly solidified. Thus the deposits become enormous, the fusion spending itself, and thus retarding its progress towards Hilo.

The whole breadth of the lava stream lies between the river Wailuku whose course is east, and one of its largest tributaries which flows from the southwest. As we have said, this branch was our route by which we threaded our way to the fires, the lava stream lying within half a mile of its banks, at the place where we left it, and having fallen into its head waters above us. An effort to cut across below the lava stream was made that we

might get a more definite idea of its width, that we might obtain a front view of it, and, finally, that we might reach the channel of the Wailuku and descend in it to Hilo, the passage along this stream being much easier than in the branch by which we had reached the fire. Previous to our efforts to cut through the woods from one stream to the other, we had made an attempt to cross directly over *on the lava stream itself.* This we tried first directly from our camp; but failing here, we beat our way through the thicket up the verge of the stream, hoping to find a point where the fires were less active.

At length we made another effort to cross. But the hardened surface of the stream was swelling and heaving at innumerable points by the accumulating masses and the upraising pressure of the fusion below; and valves were continually opening, out of which the molten flood gushed and flowed in little streams on every side of us. Not a square rod could be found on all this wide expanse where the glowing fusion could not be seen under our feet through holes and cracks in the superincumbent stratum on which we were walking. The open pots and pools and streams we avoided by a zigzag course; but as we advanced, these became more numerous and intensely active, and the heat becoming unendurable, we again beat a retreat after having proceeded some thirty rods upon the stream. It may seem strange to many, that one should venture on such a fiery stream at all, but you will understand that the greater part of the surface of the stream was hardened to the depth of from six inches to two or three feet; that the incandescent stream flowed nearly under this crust like water under ice, but showing up through ten thousand fissures and breaking up in countless pools. On the hardened parts we could walk, though the heat was almost scorching, and the smoke and gases suffocating. We could even tread on a fresh stream of lava only one hour after it had poured out from a boiling caldron, so soon does the lava harden in contact with the air. Finding no way to cross the igneous flood, and the rain falling in torrents, our guide admonished us that we must hasten back, as the water course up which we came was rapidly filling. We therefore reëntered the channel at ten A. M., and found the stream so swollen and so grand in its wild rushings and plungings, that it was with the greatest difficulty and danger we effected a retreat. Mercifully we reached home, scorched, smoked, exhausted, and "water-logged."

Nov. 20th.—Three different parties have returned from the fire since this letter was commenced. It has made two miles progress since my return and it is estimated to be within eight miles of the shore. Notwithstanding the winding and difficult way, one can now go up, dip up the fusion, and return the same day.

It is only four hours walk from us, and it might be reached in two hours, were the route direct and the road good. The rate of progress now is about one mile a week. It may come faster when it gets through the forest. Probably six or eight weeks will decide the question whether Hilo shall remain in its verdant robes or be swept with a besom of fire.

ART. XXVIII.—*On Volcanic action at Mauna Loa;* by JAMES D. DANA.

THE recent eruption of Mauna Loa, so vividly described by the Rev. Mr. Coan of Hilo, sustains fully the conclusions of the writer in his Expl. Exp., Geological Report; and as those conclusions are, in part at least, at variance with preconceived notions, a review of them will not be out of place. It will probably require many reiterations of the facts, before so magnificent an attendant upon volcanoes as earthquakes shall be allowed to have only an incidental place among the phenomena.

The main conclusions to which I refer, are briefly as follows:—

1. *The quietness of the eruption.*—According to Mr. Coan, the lava has reached in its windings a distance of 65 miles: yet it broke out *without an earthquake;* as in the eruption of 1852 and 1846, a light on the mountains was the first announcement. The progress also has been as quiet as the commencement.

2. *The eruption through opened fissures.*—The craters at summit did not overflow; the mountain was broken through at a height of 12,000 feet—and the fissure or fissures continued down the mountain, the lavas flowing in the fissure at a rapid rate—as they should, with a head, more than 12,000 feet above the sea; —in some places overflowing, and spreading widely, and in others confined to the fissure.

Mr. Coan describing the *appearance*, speaks as if the lavas occupied a channel or covered way. It is obviously impossible that a volcano should open any other channel through its sides than a fissure. The forces are, 1st, the hydrostatic pressure of the lava column in the mountain; and 2nd, the expansive force of vapors arising from the igneous mass below. The fracture produced must be a fissure opening from below upward, or several fissures along a common direction; and the fissure or fissures may extend so as to reach the surface only at intervals, so that the outbreaks shall be more or less interrupted. Thus it has been in all the modern eruptions of Mauna Loa and Kilauea. The idea of a shaft being suddenly struck through, so as to become the conduit of a side crater, and this crater the source of lava of the eruption, is wholly opposed by the facts on Hawaii, as well as

by the very nature of volcanic forces. The fractures of such a vast mountain as that of M. Loa—14,000 feet high, and 50 miles in diameter at base, must have their starting point from a depth as far down at least as the water level; and if such a fracture opens so as to make a fissure of a mile anywhere at the surface, it will have many times that length below; moreover, owing to the strain producing such a rupture within, there would probably be several other lines of surface fracture, along the slopes between the first outbreak and the sea.

The lateral cones formed along the line of such an eruption mark the points of widest fracture or the intersections of fractures, and are not the sole sources of the lava.

3. *A volcanic mountain whose average slope is* 6° *to* 7° *may have eruptions extending from the summit to the base.*—The three great eruptions of M. Loa directly sustain this fact. Moreover, as Mr. Coan states, while the average slope is 6° to 7°, there are many intervals where the angle is 25° to 30°, and some of 49° and 60° or more, down which the lavas poured, and where they afterwards hardened. We have not however definite statements as to the thickness of the lava stream along these steeper declivities. The facts at least set aside the notion that the lavas of a crater are thrown out at an angle not exceeding 3°, and that a higher angle is a result of elevating forces below at centre, thumping it upward. Elevation by uplifting action beneath is part of the history of every lava cone. But it begins, as the facts in Kilauea prove, with the first formation of the cone, and continues with its progress—growth by overflow and elevation going on together; and if there be any difference, the uplifting action should diminish (instead of decrease,) as the crater loses its original activity.

4. *The basaltic character of the lavas.*—The rock, Mr. Coan states, is similar to that of the other eruptions. Indeed the recent lavas all over Hawaii are much alike; they vary in the amount of chrysolite, but otherwise are quite similar. There are no trachytic or phonolitic lavas, among the modern products, although a true phonolite, almost a porphyry, occurs among the rocks at the very summit of M. Loa, near the central crater.

5. *No lofty cinder ejections.*—Those eruptions of fiery cinders, which mark so strikingly the spiteful Vesuvius are almost wholly wanting about the craters and eruptions of M. Loa. Instead of jets of glowing fragments to a height of one to ten thousand feet as in the Italian volcano, they rise when highest only to three or four hundred feet, and to this height only in connection with the last breathings of some lateral cone attendant upon an eruption.

The idea therefore that the larger the crater the greater the projectile force, is utterly at variance with facts and reason. M. Loa

contains material enough for one hundred and twenty-five Vesuviuses: and two thousand feet below its summit it has a thickness of twenty miles,—a massiveness in the great volcano that would seem to fit it for lofty projection towards the celestial regions; and yet it makes out to toss its little cinders a few hundred feet when it does its best. This is not strange, when it is understood that in a boiling fluid, whether lava or anything else, the projectile force of the escaping vapors depends on the viscidity of the fluid, and also the narrowness of the vent above: and where the lavas have the fluidity that enables them to make craters three miles in diameter and mountains fifty miles broad, or the far larger dimensions that are observed in the moon, they must necessarily make a poor fist at throwing stones.

6. *The process of eruption cyclical and not paroxysmal.*—It has been a common opinion that the eruptions of volcanoes depended on some accidental ingress of waters, or formation of vapors. But on Hawaii, both Kilauea and also the central or summit crater of M. Loa show that after an eruption there is a gradual progress in the lavas, until their accumulation and the pressing vapors force another outbreak. The process goes on constantly in regular systematic action: and when the time of outbreak comes, it takes place as if it were in the direct line of operations, and not as an accidental catastrophe.

Kilauea, in 1823, 1832, and 1840, had grand eruptions. In each case, the crater, a thousand feet deep and seven and a half miles in circuit, was filled up, just before the outbreak, four or five hundred feet; and at the eruption, the lavas sunk to the former level: the cauldron had been tapped and to that level emptied.

In 1849, it was again filled, but afterwards became quiet, the lavas sinking away, though without a sinking of the craters bottom. There was evidence in this of a partial eruption, though the fissures did not reach the surface of the island. According to the account by Mr. Coan, Kilauea was again the past year in extraordinary activity: and whether it will this time break through to the surface remains to be seen.

The great central crater of the same mountain pursues a course like that of Kilauea. But it is remarkable that after such an eruption as that of 1852,—when the lavas first broke out at an elevation of 13,500 feet, and then, four thousand feet below, in a magnificent fiery jet of liquid rock, one thousand feet in diameter and three to seven hundred feet high, evidently worked by the head of lava in the central lavas of the mountain—another should have taken place in the same quiet business-like way within three years, breaking out 12,000 feet above the sea.

7. More wonderful than all else connected with M. Loa is the fact of such an outburst of lavas and so free a play of lava foun-

tains at heights of 10,000 to 14,000 feet, when Kilauea on the flanks of the same mountain 6000 to 10,000 feet below, hold its capacious gulf wide open, and heedless, keeps on its boilings and mutterings. A syphon with the fluid lava standing in one leg 10,000 feet higher than the other, and yet without sympathy between the two—the upper at times even playing a jet of 1000 feet diameter and many hundred feet high,—is a strange problem for the geologist. Deny the connection,—and the hypothesis of a communication now existing betwen a modern volcano and the earth's interior fires has but a poor foundation. Admit the connection,—and a mystery remains to be solved.

We may say that a connection exists; and that, as the craters are twenty miles apart, the junction may be at least 100 or 150 miles below; so that the friction or resistance to free motion in the long conduit is not more than counterbalanced by 10,000 feet in height of lava.—Or, we may suppose, as the writer suggests in his Report, that as the action causing the eruptions is comparatively superficial or within a depth of a few miles, it being in fact, a rising from developed vapor, as a vessel of fermenting syrup froths over, (as suggested by C. Prevost,) such an action, a kind of inflation, does not necessarily increase much the weight of the column compared with that of its whole length.

Both causes may indeed operate. Still, supposing the lava column of the central crater two miles in diameter at top and that of Kilauea three miles, these being the diameters of the craters, we should naturally infer that the heat and the diameter would increase downward rather than decrease; and that the passage of the syphon would therefore be free. Yet the law of latent heat, by which much more heat is required to produce fusion than the sensible heat of the fused material, makes it possible that a melted mass may be held within a basin made of the same material unmelted, as water in a basin of ice; and it also increases the facility with which the melted mass, be it even the conduit of a volcano, would be encroached upon by the cold rock, the latter congealing it by conduction.

This great question may therefore be regarded as still unsettled. If the thickness of the earth's crust be but thirty miles, as has been sustained on good grounds, it exceeds only one-half the distance between the summit crater of M. Loa and Kilauea; and in that case a connection of the two conduits could hardly take place at all except through the central fluid mass of the globe; for to bring them together within twenty miles of the surface would require a rapidity of convergence between them, which, although possible, cannot be deemed probable.

Art. XXIX.—*Investigations on the Properties of Telluramyl and Selenmethyl;* by F. Wöhler and John Dean.*

[Read before the American Academy, by Prof. Horsford.]

1. *Telluramyl.* $C_{10}H_{11}Te$.

Telluramyl was prepared by a method analogous to that employed in the preparation of tellurethyl; viz., by distilling tellurid of potassium with sulphamylate of lime. The combination is readily formed, though not so easily as in the case of the methyl compound, nor is it attended with so much frothing. By gently heating, yellowish vapors soon form, which condense to yellowish red drops of telluramyl, passing over together with water, under which it sinks. Soon however drops of undecomposed fusel oil are seen to accompany it, and we could not succeed in separating the two completely. The method which gave the nearest approach to success was the following: the mixture of telluramyl and fusel oil was dissolved in concentrated nitric acid, and as the fusel oil dissolved with much difficulty, the greater part of it could be volatilized before going into solution. Sulphite of ammonia was then added, by means of which the telluramyl was reduced and precipitated in oily drops. It was separated from the fluid by distillation. The surface of the telluramyl obtained in this manner was invariably coated with reduced tellurium. Towards the close of the original distillation, a thick, almost solid matter was obtained, of somewhat darker color than the first distillate, which was probably a bitelluret.

Three analyses of different portions of telluramyl obtained as above gave the following results.

C_{10}	44·4	39·5	38·3	36·1
H_{11}	8·1	7·4	8·2	6·9
Te	47·5	37·0	35·4	
	100·0	83·9	81·9	

It is evident from these analyses that the substance analysed was impure.

The carbon and hydrogen of the first analysis agree very closely with the composition of the still unknown tellurbutyl C_8H_9Te which would contain in 100 pts.

C	39·60
H	7·42
Te	52·98

* From an Inaugural Dissertation, On the Organic Compounds of Tellurium and Selenium. By J. Dean, Göttingen, 1855.

The estimated amount of tellurium however differs very widely from this. But if we reckon it from the loss we obtain 53·1 and 53·5 per cent, numbers agreeing very closely with the formula. We can perhaps think that in this compound, only $\frac{2}{3}$ of the tellurium is precipitated, when treated by the general method for the estimation of tellurium. We must further think that under such conditions, butyl C_8H_9 together with C_2H_2 is formed from amyl $C_{10}H_{11}$ which perhaps can occur from the action of the sulphuric acid upon the fusel oil in the preparation of sulphamylate of lime. Whatever this body may be it appears to be separated with the aid of heat into tellurium and the alcohol radical, depositing even when heated in an atmosphere of carbonic acid gas, metallic tellurium in beautiful crystals, and as this decomposition must have already begun during the original preparation, it is easy to see that the product must be mixture of different bodies. At any rate the body which is the chief constituent, is entirely analogous to tellurmethyl and tellurethyl in its reactions, being a radical combining with oxygen, chlorine, etc.

Telluramyl is a reddish yellow liquid heavier than water, of a disagreeable, though somewhat aromatic smell. A portion from the specimen analyzed boiled at 198° C. On exposure to the air it is oxydized, leaving a white residue: distilled in an atmosphere of carbonic acid gas, it deposited a considerable portion of finely crystallized tellurium.

Nitrate.—By the action of nitric acid a yellowish white resinous substance is formed, of a pleasant etherial, aromatic odor, soluble in boiling water, from which a part is deposited in oily drops on cooling: by allowing the remaining solution to stand for several days, the nitrate crystallizes out in clear, transparent, colorless plates. The crystals heated in a closed tube melt and burn with a blue tellurium flame. It fuses at 40° C.

An analysis of the crystals gave 37·8 per cent. of tellurium; had the compound been $C_{10}H_{11}TeO, NO_5$ it would have given 32·56 per cent. The formula $C_{10}H_{11}TeO, HO + C_{10}H_{11}TeO, NO_5$, corresponding to the formula of the sulphate and oxalate of tellurethyl*, gives 36·9 per cent.

Chlorid.—Hydrochloric acid precipitates a clear, colorless, heavy oil, without odor, when added to a solution of the nitrate.

Bromid.—Hydrobromic acid precipitates a clear, pale yellow, heavy oil, without odor.

Iodid.—This is precipitated, on the addition of hydriodic acid or iodid of potassium, in yellow drops which collect together as a dark red oil, heavier than water. Boiled with alcohol it is changed into a pale yellow amorphous powder, without odor, which becomes vermillion red when treated with ammonia, and

* Ann. Chem. Pharm. lxxxiv, 75, 76.

dissolves by heating; on cooling it is deposited again as a vermillion powder, from which nitric acid removes the iodine.

Oxyd.—The chlorine compound, treated with oxyd of silver and water, formed a strongly alkaline solution, depositing chlorid of silver. The solution on being evaporated to a syrupy consistence possessed strong alkaline properties, evolving ammonia from chlorid of ammonium. On the addition of hydrochloric acid the chlorid was formed. Sulphurous acid reduced reddish yellow drops of telluramyl.

Sulphate.—Obtained by treating the oxyd with sulphuric acid: on evaporation the salt crystallizes in groups of small colorless prisms.

2. *Selenmethyl.* C_2H_3Se.

The recent experiments of Joy* upon selenethyl, and those of Wöhler upon tellurethyl† and tellurmethyl‡ induced us to investigate the corresponding compounds of selenium with the radical of methylic alcohol, with a view of establishing more completely the analogy between the organic compounds of selenium and tellurium. We have not succeeded in obtaining compounds analogous to Joy's selenethyl series; but, as will be seen in the following pages, have obtained a series of bodies possessing entirely different properties, being much more closely allied to the compounds of sulphur with the alcohol radicals, than to those of tellurium. It is to be regretted that, owing to the small quantity of material, we had to work with, these experiments are very incomplete; but they appear to be sufficient to indicate that the radical selenmethyl is possessed of very remarkable properties, and will serve to form the groundwork at least of future and more complete investigation.

The method employed in preparing selenid of potassium was the following. Powdered selenium was converted into selenious acid by the action of concentrated nitric acid, the solution evaporated until all the nitric acid was expelled, and a mass of white needle crystals of selenious acid remained sublimed in the flask. The selenious acid was then dissolved in water and saturated with potassa, the solution mixed with finely powdered charcoal, evaporated to dryness, and heated some time in order to expel as much water as possible from the porous mass. The mass was then very gently heated in a glass retort: the reduction took place at quite a low temperature, attended by vivid deflagration spreading itself gradually through the whole mass, which glowed and shrank almost as if fused: so vivid was the deflagration that a small quantity of metallic selenium was lost, going forth from the neck of the retort in copious red vapors. After the retort

* Ann. Chem. Pharm. lxxxvi, 35.
† Ann. Chem. Pharm. lxxxiv, 69.
‡ Ann. Chem. Pharm. xciii, 223.

was quite cold, it was broken, the mass coarsely pulverized and thrown into a flask containing a solution of sulphomethylate of baryta, the flask quickly connected with a Liebig's condensing apparatus, and the solution distilled: the chief difficulty which occurred was from the excessive foaming of the liquid as soon as it was heated which however can be mostly obviated by heating the flask from the sides, and not from the bottom; but notwithstanding all precautions the quantity of foam was so great, that we were obliged to purify the selenmethyl by redistillation. It was unnecessary to fill the flask and other apparatus with carbonic acid gas, as the selenid of potassium does not appear to be as easily oxydizable when exposed to the air as the telluride: care however must be taken to have the apparatus prepared beforehand so as to expose the selenid to the air as little as possible, and the solution must be distilled rapidly at first to expel the air from the apparatus. The selenmethyl appears to be formed in the solution very easily, as its characteristic odor can be perceived almost immediately, and, as soon as the flask is heated, yellow vapors can be seen to form, condensing to clear yellow oil drops on the neck of the flask.

Selenmethyl is a clear, reddish yellow, very mobile fluid heavier than water, with which it is not miscible, of an extremely offensive etherial odor, resembling very much the odor of the tellurium and sulphur compounds of ethyl and methyl: it is easily ignited, burning with a bluish flame: on exposure to the air for some time it is oxydized. It dissolves in cold concentrated nitric acid with great facility, the acid often becoming quite warm from the violence of the reaction. Hydrochloric acid gives no precipitate when added to the acid solution. Sulphurous acid reduces selenmethyl.

If the nitric acid solution be evaporated to the consistence of a syrup, a new reaction takes place, appearing to be a further oxydation of the selenmethyl, attended by a very considerable evolution of nitric oxyd: this evolution becomes at last so violent, that if greater care is not taken in the application of heat, the mass is entirely decomposed with violent deflagration, and production of extremely acrid vapors of an intensely disagreeable and penetrating odor, which are almost insupportable, and attack the eyes with such acridity as to occasion blindness for some minutes.

If proper care be taken however, the oxydation can be carried on slowly until the solution is nearly evaporated to dryness: on cooling, the syrupy mass crystallizes in beautiful colorless groups of needle crystals, which increase in size till the entire mass becomes solid.

These crystals possess strong acid properties, appearing in fact to constitute a new acid.

They are quite deliquescent, very soluble both in hot and cold water and also in alcohol, having a disagreeable odor, and a most disgusting metallic taste which continues for a long time in the mouth. Ignited they burn with a blue selenium flame. Sulphurous acid reduces from their solution selenmethyl. Hydrochloric acid gives no precipitate.

The crystals melt at 122° C., to a clear yellow fluid, which becomes on cooling a yellow crystalline mass: on heating further it deflagrates slightly, burning with a strong, very acrid smell, and attacking the eyes. On heating in a closed tube it is partially decomposed at about the melting point, and a small quantity of yellow oil is volatilized, smelling like selenmethyl: by increasing the heat it is decomposed, and crystals of selenious acid are formed in the cool part of the tube, together with water and drops of a beautiful dark red oil, part of the selenium remaining behind in fused globules.

On dissolving this crystalline body (produced by the action of nitric acid on selenmethyl) in ammonia, a crystalline salt is obtained, from which potassa sets free ammonia.

Silver salt.—The acid, on being mixed in an agate mortar with carbonate of silver, (prepared by precipitating a solution of the nitrate with carbonate of soda, and carefully washing the precipitate,) was immediately acted upon on moistening the mass with water, carbonic acid being evolved in considerable quantity. The mass was then placed upon a filter and washed for a long time with hot water, as the silver salt seems to be soluble with difficulty. By evaporating the solution, beautiful stellate groups of fine colorless and transparent needle crystals are obtained.

This body is probably analogous to the acids obtained by the action of nitric acid upon the sulphids of ethyl and methyl, which have for their formulæ

$$\left.\begin{matrix} C_2H_3O \\ H\ \ O \end{matrix}\right\} S_2O_4 \text{* and } \left.\begin{matrix} C_4H_5O \\ H\ \ O \end{matrix}\right\} S_2O_4 \text{†}.$$

The formula for this acid would accordingly be

$$\left.\begin{matrix} C_2H_3O \\ H\ \ O \end{matrix}\right\} Se_2O_4 \text{—or, } C_2H_4Se_2O_6;$$

And that of the silver salt would be

$$\left.\begin{matrix} C_2H_3O \\ AgO \end{matrix}\right\} Se_2O_4 \text{—or, } C_2H_3AgSe_2O_6.$$

Several analyses were made from this salt; but we could arrive at no satisfactory results, as in the silver determinations the chlorid of silver was always rendered impure through admixture of selenium or selenid of silver, which appeared to be precipitated

* Kolbe, Ann. Chem. Pharm. liv, 174. † Gerhardt, Traité de Chem. Organ. ii, 287.

with the chlorid, rendering the latter when fused quite black. 0·8825 grm. dried at 100° C. gave 0·5355 grm. chlorid of silver. 0·6597 grm. gave 0·4025 grm. chlorid of silver.

		Found.	
C_2	4·8		
H_3	1·2		
Ag	43·2	45·8	45·9
Se_2	31·6		
O_6	19·2		
	100·0		

These estimations differ somewhat widely from the theoretical formula, and it is to be regretted that lack of material prevented us from making further determinations; but the formula is better established by the analysis of the chlorine compound, which will be presently given. The silver salt heated in a closed tube is very easily decomposed, puffing and burning, forming water, selenious acid and selenid of silver. By continued heating of a solution of the salt even below the boiling point, it is slightly decomposed, depositing metallic silver and selenid of silver. The crystals themselves by drying in the air change color somewhat, like all silver salts, showing a beautiful silvery surface; they are slightly decomposed by continued heating at 100° C., and burn giving off red vapors of selenium at 110° to 120° C.

Baryta Salt.—By neutralizing the acid with ammonia, and adding chlorid of barium to the hot solution, the baryta salt is obtained as a white, crystalline precipitate. From the analysis of this salt we could only conclude, owing to the small quantity we had, that it probably contains two equivalents of baryta to one of the acid.

The great difficulty in the analysis of these salts consists in their easy decomposition by heating, either when dry or in solution. They all possess the same smell and disgusting metallic taste as the acid itself.

Chlorine Compound.—To a solution of the above-mentioned acid hydrochloric acid was added; no precipitate was formed, but by gentle evaporation, beautiful transparent needle crystals were formed: when free nitric acid was present, only an amorphous mass was obtained.

These crystals, which have a strong acid reaction, are probably a simple substitution product, in which one atom of chlorine takes the place of an atom of oxygen, the reaction being as follows:

$$\left.\begin{matrix} C_2H_3O \\ H\ O \end{matrix}\right\} Se_2O_4 + HCl = \left.\begin{matrix} C_2H_3Cl \\ H\ O \end{matrix}\right\} Se_2O_4 + HO.$$

An analysis of the crystallized body, dried over chlorid of calcium, gave the following results:

0·364 grm. of the body gave 0·097 grm. CO_2 and 0·106 grm. HO.

0·684 grm. gave 0·313 grm. of selenium.

0·9788 grm. gave 0·8477 grm. of chlorid of silver.

0·719 grm. gave 0·6035 grm. of chlorid of silver.

		Found.	
C_2	7·0	7·2	
H_4	2·4	3·3	
Cl	20·8	20·7	21·0
Se_2	46·3	45·7	
O_3	23·5	23·1	
	100·0	100·0	

The determination which agrees least with the calculation is that of the hydrogen, which may easily be too great, as the crystals are decomposed under 100° C.

Heated in the air the compound burns with the characteristic blue selenium flame. It melts at 88°—90° C. to a clear, dark brown oil, (being probably partially decomposed,) solidifying on cooling to a dark apparently amorphous mass. Heated in a closed tube it melts and burns, part of the selenium being sublimed as selenious acid, while another portion is reduced and remains behind in fused globules, drops of a yellow oil being also formed.

It is very soluble in water and alcohol, but is apparently not deliquescent; it has quite an unpleasant smell, and most disgusting taste; it gives no precipitate with bichlorid of platinum. Sulphurous acid reduces from its solutions a dark red fluid, apparently heavier and of thicker consistency than selenmethyl, (perhaps biselenmethyl). Hydriodic acid precipitates a dark black oil, an iodine substitution product. The chlorinated product dissolves easily in ammonia, forming a salt, crystallizing in prisms collected together in stellate groups, from which potassa sets free ammonia. Mixed with oxyd of silver and moistened, it is instantly decomposed with violent reaction and evolution of heat, as soon as the water touches it: the mass was then placed upon a filter and washed with hot water; on evaporation crystals were obtained in long fine needles, colorless and transparent, clustered together in thick stellate groups; they are somewhat insoluble in water, and give with hydrochloric acid a precipitate of chlorid of silver. A solution of the salt is somewhat decomposed by heating, depositing a small quantity of silver. Owing to the very small quantity of this salt which we had, we were unable to investigate further its properties. In the form of its crystals and all its physical properties, taste, odor, etc., it closely resembles the silver salt described above (p. 249). This chlorin-

ated product $\left.\begin{matrix}C_2H_3Cl\\H\\O\end{matrix}\right\}Se_2O_4$ may be another acid forming salts of the formula $\left.\begin{matrix}C_2H_3Cl\\R\\O\end{matrix}\right\}Se_2O_4$: or $\left.\begin{matrix}C_2H_3Cl\\H\\O\end{matrix}\right\}Se_2O_4$ may with RO form RCl and regenerate the acid $\left.\begin{matrix}C_2H_3O\\H\\O\end{matrix}\right\}Se_2O_4$, forming, with the excess of RO present, salts of the simple acid. The latter appears to be the more probable view.

Bromine Compound.—By adding hydrobromic acid to the chlorinated body, a very slight white precipitate is formed, which redissolves on heating: by evaporation, a crystalline substance is obtained, which melts and is probably decomposed considerably under 100° C., forming a black oil resembling bromine: on cooling this hardens to a black semi-crystalline mass, nearly insoluble both in water and alcohol, but somewhat soluble in ether, which dissolves out a substance crystallizing in transparent yellow plates. By adding to the solution of the chlorine compound free hydrobromic acid, and allowing the solution to evaporate by exposure to the air, beautiful, transparent, flat yellow prisms are obtained, which easily decompose by contact with organic substances; from the mother liquor, sulphite of ammonia precipitates a splendid scarlet oily body, together with free selenium. The crystals obtained by spontaneous evaporation are without doubt a substitution bromine compound, probably of the formula $\left.\begin{matrix}C_2H_3Br\\H\\O\end{matrix}\right\}Se_2O_4$. They are very soluble in ammonia, and form a crystalline salt, from which potassa sets free ammonia.

The bromine compound on heating melts, and burns with the same appearances as the chlorine compound.

Iodine Compound.—On treating the preceding bodies with hydriodic acid or with a solution of iodid of potassium, a precipitate was formed consisting of minute drops of a reddish black oil, which soon collected together forming a very heavy black oil, with a shining greenish metallic luster, of extremely disagreeable odor: it is quite soluble in an excess either of hydriodic acid or iodid of potassium, slightly soluble in water, to which it imparts an orange-yellow color, quite soluble in alcohol: by allowing the alcoholic solution to spontaneously evaporate, it passes off with the alcohol vapors, leaving no residue. On allowing this oily precipitate to stand for some time in a closed tube, part of it appeared to become solid, as if crystals were formed in the oily mass; but I was unable to study their properties.

On one occasion by adding a solution of iodid of potassium to a solution of the first acid, (obtained by the action of nitric acid on selenmethyl,) a precipitate was formed, which redissolved on heating, and by evaporation was obtained in fine red crystals:

we were however unable to obtain the same body again, although the experiment was repeated several times with every precaution, and are therefore unable to conjecture what these crystals were.

The conclusions which the foregoing experiments seem to indicate are as follows:

1st. The continued action of nitric acid on an alcohol radical containing selenium produces, besides a nitrate of the oxyd of the radical, as in the case of selenethyl (according to Joy), and tellurethyl and methyl, a new acid, probably analogous to the acid produced by the continued action of nitric acid on the compounds of sulphur with the radicals ethyl and methyl; the formula of the acid being by analogy $\left.\begin{matrix} C_2H_3O \\ H\ O \end{matrix}\right\} Se_2O_4$, to which the name of selenomethylic acid might be given.

2ndly. The chlorinated product is probably a simple substitution product, in which one atom of chlorine is substituted for one atom of oxygen.

$$\left.\begin{matrix} C_2H_3O \\ H\ O \end{matrix}\right\} Se_2O_4 + HCl = \left.\begin{matrix} C_2H_3Cl \\ H\ O \end{matrix}\right\} Se_2O_4 + HO$$

The product which Joy obtained,* by allowing chlorid of selenethyl to remain for some time in a solution containing free nitro-hydrochloric acid, is without doubt the corresponding body of the ethyl series. He was unable to obtain these crystals in an arbitrary manner. They appeared to be an acid, forming a crystalline mass with ammonia, which latter was liberated on the addition of potassa. The formula for the corresponding ethyl compound would be $\left.\begin{matrix} C_4H_5Cl \\ H\ O \end{matrix}\right\} Se_2O_4$.

The result of his analysis is as follows:

			Joy.
C_4	13·0	—	13·6
H_6	3·3	—	4·2
Se_2	42·8		
Cl	19·2	—	20.6
O_5	21·7		
	100.0		

3dly. Treatment with hydriodic and hydrobromic acids gives similar products.

4thly. The chlorinated body $\left.\begin{matrix} C_2H_3Cl \\ H\ O \end{matrix}\right\} Se_2O_4$ may either give salts corresponding to the formula $\left.\begin{matrix} C_2H_3Cl \\ R\ O \end{matrix}\right\} Se_2O_4$ or with the oxyd RO may form $\left.\begin{matrix} C_2H_3O \\ H\ O \end{matrix}\right\} Se_2O_4$ and RCl, the original acid

* Ann. Chem. Pharm. lxxxvi, 35.

being regenerated, and forming with the excess of RO, $\left.\begin{matrix} C_2H_3O \\ R \end{matrix}\right\} O \Big\} Se_2O_4$. The latter view seems to be the more probable, as the salts obtained both from the bromine and chlorine bodies were exactly similar in physical properties to the salts of the simple acid.

5thly. In the body obtained by the continual action of nitric acid on selenmethyl, selenium seems to display a close analogy to sulphur; while in the case of the products obtained by Joy from selenethyl there seemed to be also a close analogy between selenium and tellurium: thus selenium appears in its organic compounds of the alcohol series to fulfill the functions both of sulphur and tellurium, and may justly be regarded as the connecting link between these bodies.

ART. XXX.—*Correspondence of M. Jerome Nicklès, dated Paris, January* 5, 1856.

Death of M. Sturm.—Mathematical Science has experienced a great loss in the death of the geometrician Sturm, the author of the theorem which bears his name and which has done so much for the progress of Algebra. Besides a series of memoirs on differential equations and on partial differences, he has also published a memoir on vision, another on optics, important researches on mechanics, and in particular, a remarkable theorem on the variation which force undergoes when a sudden change is given to the parts of a system in motion.

Sturm entered the Institute in the place of Ampère, and in many respects he resembled him. He was, like him, candid, indifferent to the wealth and show of the world, gifted with an inventive mind united with an encyclopedic range of knowledge, neglected or even disdained by those skilled in office seeking, but exerting a high influence over the youth of schools who admire genius, and possessing, without having desired it or hardly knowing it, an immense popularity.

M. Sturm died at the age of 51 years, in consequence of a moral as much as physical malady which for some years has prevented his laboring for the progress of science.

Death of Adrien Chenot.—The fertile inventor, who has often been mentioned in this Journal, the originator of a new system of Metallurgy, which the "Universal Exposition" has rewarded with the grand medal of honor, for an "Ensemble remarquable de faits nouveaux et importants au point de vue metallurgique, particulièrement pour les procédes économiques appliques au traitement des minerais de fer pour obtenir le métal," has died, just after his triumph, and at the time when he was gathering the fruit of his long labors, and when the prospect of a brilliant future to his family was attaching him most strongly to life.

I mentioned not long since, in giving an account of the toxical effects of carbonic oxyd,* that M. Chenot was the first to try them;

* This Journal, Jan. 7, 1854, p. 120.

that he experimented on himself, and that he had since continued in a sickly febrile condition. His limbs trembled and at times he had fainting turns. A fit took him as he went out upon the balcony of his chamber to take the air. He remained there a moment resting on the balustrade his body inclined a little towards the street; the fit increased instead of diminishing, his strength failed him, and as the balustrade was low, he fell over to the ground, a height of four stories. It was on the 27th of November, 1855. Chenot was 50 years old.

The inventions and discoveries of M. Chenot have a universal importance; and yet they are not known as they merit to be, as he had not the talent of pushing his labors into notice. In 1836 he prepared some of the metals in the spongy state and made known their curious properties. He afterwards applied this property to the treatment of ores and the fabrication of steel, and raised this part of metallurgy from the empiricism in which it had hitherto remained. He pointed out a method of determining which ores are the best for steel, showing that in case of two ores of the same composition, the measure of value was marked by the relative quantity of cement which the metal that the ore affords, will take up without becoming brittle; thus, between the ore of the Ural and that of Elba, the former will imbibe 6 p. c. of carbon, without losing its malleability, while the latter is brittle with only 4 p. c. of carbon. This property of retaining more carbon he attributes to a peculiar earth which has some analogies with alumina and which is found in all ores that furnish good steel. The method of cementation is simple; it is only necessary to plunge the iron sponge into tar, oil, or some other liquid highly carbonised and then heat to fusion.

One consequence of his labors is the application of electricity to the cleaning of iron ores. The machine works automatically, and will separate many tons of ore per day, cleaning it perfectly from the earthy gangue which absorbs so much of the combustible employed in the furnaces.

The reduction of the metallic oxyds by the oxyd of carbon, or by the mixture of this oxyd with hydrogen such as is obtained in decomposing the vapor of water by coal at a red heat, will sooner or later transform the industry of the metals. In treating sulphate of lead by the iron sponge, sulphate of iron is obtained along with lead in the metallic state. By impregnating the iron sponge with boracic acid and heating, excellent steel is obtained which contains no carbon; and steel of another quality is formed by adding the ores of aluminium. Long before the bruit which has been made with regard to this last metal, M. Chenot insisted upon the part which aluminium acts in metallurgy and upon the alloys which it forms with iron.

In Chenot's view, the quality of iron depends more on the region from which it comes than upon the manner of treating the ores; the locality of the ore bed has as much influence on the iron and especially the steel, as that of the vineyard on the wine it affords.

The manufacture of the sponge can be made with all kinds of combustibles; even those which are rejected in other industrial pursuits may be employed. He first sought to normalize combustibles by getting rid of the sulphur, phosphorus, and arsenic, which affect the quality of the iron. This he accomplished by treating the ores with common

salt or an alkali. His first attempts date from 1850. In 1851 he made some trials in the Catalan Forges of Ariège. Having been denounced after the events of December, 1851, as a suspicious person by a jealous superintendent of iron works, M. Chenot was taken from his labors and thrown into prison; and this man, so useful, mild, loyal and honest, would have been transported with many other victims to Cayenne, were it not for the intervention of some influential friends.

The purification of combustibles, by means of common salt, has lately been undertaken in England; and it has been stated that in the process the sulphuret of iron is transformed into chlorid of iron which is volatilized and sulphuret of sodium which flows off with the scoria; but this practice is evidently bad, for at a high temperature sulphuret of sodium is decomposed by iron.

Another invention, full of promise, due to M. Chenot, is the application of the hydraulic press to the compression and molding of metallic substances. By compressing the sponges in the cold, he obtained results which dispense with the employment of high temperatures and produce an economy of combustible amounting nearly to 75 per cent. He was convinced that with sufficient force, the moulding of metals in the cold would become almost universal, even for forms the most complicated, and with various combinations of metals whatever art may require, so that copper, iron, steel, gold, silver, etc., may be combined in any way that may be desired.

There are endless applications in the inventions of M. Chenot. Unfortunately, this inventor had not the talent to see his true interests. Instead of exhibiting in his writings the importance of the metallic sponges and their many uses, he indulged in long discursions on the physics of the globe, and in throwing out philosophical views far more appropriate in a special work. In this way he repelled practical men, and Chenot was unnoticed at the London exhibition. He was near being overlooked at the Paris exhibition. But on studying the processes of the method of Chenot, and examining the products, Mr. T. Sterry Hunt from Canada was enabled to exhibit the facts to his colleagues on the jury, and put them in the way of doing justice to a man whose inventions had long been neglected. It is not common that earnest inventors succeed in France. Capitalists of little intelligence prefer to risk their capital on foolish enterprises put in train by men of adroitness and tact. Moreover, Chenot's method was not first appreciated in France. His encouragements came to him from Spain, where for many years, his processes have been in practice. There is a large establishment in Biscay, copied after that of Cléchy la Garenne, which was founded by the Spanish metallurgist, M. Villalonga, who had spent some time in the laboratory of Chenot, and who had studied his system. The journals have not rendered justice to Chenot any more than industrial men, or men of science. To this general silence, the American Journal of Science may claim rightly to be an exception. Men of genius, as more than one example has shown, may be ignored or even contemned in France; and justice has often first come, as in the case of Chenot, through foreigners.

"*Universal Exposition.*"—If the reader will run over the list of laureates of the Paris exhibition, he will find many names which the

American Journal has rendered familiar, as Boutigny, Ruhmkorff, Duboscq, Soleil, Deleuil, Perreaux, Thomas de Colmar, Franchot, Mirand, Dumoncel, Dubrunfaut, Leplay, DeMilly, Aubert and Gerard, Kestner, Silbermann, all of which names attest to the spirit of justice with which we have reviewed the progress of discovery in this journal, and anticipated official honors. Mr. Goodyear has received the Grand Medal of Honor, of the 10th class, for his discoveries and inventions connected with India rubber.

Telegraph across the Mediterranean.—Among the inventors who have received the decoration, there occurs with justice the name of M. Jacob Brett, the maker of the first submarine cable. He had nothing on exhibition, but his brother had brought forward specimens of the cables which had been laid. When the prizes were under discussion, M. Babinet, vice-president of the jury of the 9th class, and as such, member also of the jury of presidents, proposed a reward to M. Brett, stating that he merited the medal of the "Legion d'Honneur." But as the name of John Brett was alone on the catalogue, he received the nomination and was felicitated on the honors he was to receive on the morrow. He called to thank M. Babinet, when the latter perceived the mistake that had been made, and hastened to correct it by substituting the name of Jacob Brett, who was found with some difficulty and drawn out of his retreat in order to be present at the distribution.

John Brett would have been decorated had he not failed in his attempt to lay down the Mediterranean cable. The failure moreover was not his fault. No steamer could be found large enough to take the third section of the Algerian cable, it being 200 kilometers long and weighing more than 1500 tons; and they were therefore compelled to freight a sailing vessel, the *Result*, of 1700 tons burthen. The vessel was ready by the 30th of July, and on the 6th of September it arrived at Cagliari in Sardinia after a violent gale in the Bay of Biscay. On the 24th the *Result* accompanied by the French steamer *le Tartare*, steered for Cape Spartivento, which it reached before night. At 6 A. M. on the 25th, the cable was attached to the shore, and put in connection with the electric telegraph of the land; and at 3 P. M. the laying of the cable commenced. By midnight, 22 miles had been laid. At 3 A. M. the work recommenced and by 9 they communicated with Cagliari, distant 40 miles. The cable had descended to a depth of 1640 meters. But the sailing vessel could make only three miles an hour, and it did not lend itself to the unrolling of the cable whose tension had become enormous from the great depth of submergence: suddenly, the cable broke the stop, and run out with a frightful velocity, three miles slipping off in ten minutes, without any possibility of stopping it, the vessel at the time hardly changing its place. In the run of the last two miles, the coarse wire enveloping the cable gave way and the cable was drawn into knots or bights. The capstan was next set to work, during the 27th to the 29th of September, and 300 fathoms were drawn up, in which only one bight was found. But on the 29th the capstan broke. The sea was tempestuous, and it created general surprise that the cable was strong enough to hold the careering vessel. On repairing the capstan, it was found that the turning around of the vessel had added to the bights in the cable, seven being counted in a length of less than four meters. Moreover the in-

sulation of the wires was no longer perfect. Finally a heavy sea caused the cable to break at the tangled bights, and all hope of recovering the cable then out was given up. A large amount of cable remained on board, and on the 5th of October another beginning was made at Spartivento. They put to sea on the 6th, and worked till ten in the evening, when the sea became exceedingly heavy, and they had to stop. The next day at ten they again commenced; but the sea was rough, and the vessel could make but little headway; and they were forced to so many deviations from their course that it was evident they would not have length enough to reach Galita. Their only course, therefore, was to cut the cable and return and wait for a more propitious season.

Such is the history of this unfortunate undertaking. Mr. Brett would have been successful during the months of January, July or August; but the terms of his engagement would not admit of his waiting, except before an impossibility.

The operation will be taken up anew by the French government; and as they have required that the line should end at Bona, the cable will have to be 200 miles long. Mr. Brett proposes, as a change, that in place of seven conducting wires, the cable should contain only three, which will suffice for the existing necessities of correspondence. The cable will then weigh only five tons per mile in place of twelve; at the same time more care will be expended on its construction. This project is accepted, and the construction of the cable for uniting France and Algiers is going on with all despatch.

Aluminium and Silicium.—The memoir of M. H. Rose on the preparation of aluminium from cryolite has been the means of important improvements in this manufacture. Deville had recognised that with the addition of fluorid of calcium to the bath of the double chlorid of aluminium and sodium, aluminium may be obtained, while it is not possible with the chlorid alone. The fluorids are therefore excellent solvents.

A mixture of alumina and fluorid of sodium wet with fluohydric acid may be decomposed by sodium, and aluminium obtained. A mixture of fluorid of potassium and fluorid of sodium is an excellent solvent. It is very fusible and is capable of dissolving much silica, some titanic acid, and a little alumina. This addition of foreign matter even augments the fusibility and renders the fusion as liquid as water. By the aid of the galvanic pile, silicium may be obtained, which forms an alloy with the electrodes unless they are of platinum.

M. Deville has satisfied himself that alumina is not decomposed by sodium, while silica is decomposed. He has even prepared sodium by bringing together capillary glass and sodium in vapor. But the great difficulty in these experiments is in the nature of the vessels used for the experiments and the alterability of the electrodes. For gas carbon is dissolved rapidly in the baths of fluorids when it is used in the preparation of silicium.

Aluminium is manufactured now on quite a large scale at Amfréville near Rouen. The vapors set free in this process are very noxious, as they consist of chlorid of silicium, chlorid of aluminium, chlorid of sulphur and chlorohydric acid. These are disposed of by interposing in their passage a furnace of lime, heated by an adjoining fire, into

which, through the draught of the chimney, come the vapors of the reducing process, and also the flame that heats the limestone.

Alcohol: new mode of manufacture.—The subject of alcohol continues to occupy attention on the European continent, and each improvement is a step towards the time when its manufacture will be wholly independent of the vine or wheat. Already we have arrived so far that on an extensive farm, alcohol is made from beets simply to obtain the pulp of the beets for fattening cattle. A process has just come out which accomplishes this last result completely, and at the same time it is founded on a scientific fact of the highest interest. Observation and invention are both known characteristics of M. Leplay, who is already familiar to our readers for the part he has taken in the manufacture of the sugar of barytes.*

Beets minced up, (or any other vegetable substance containing sugar,) introduced into the juice in fermentation, ferments in its turn; the sugar is transformed into alcohol, which remains behind and is removed by the aid of a current of steam. The process dispenses with rasping the beet and pressing out the juice. The following is the method pursued.

After washing the beets, they are cut in pieces. The form is not unimportant: they should be square, of a centimeter each side and twenty centimeters long, or ribons of three to four centimeters long, one broad and four to five millimeters thick. The beet thus subdivided is placed in the juice of the beet obtained in the ordinary way, and which has undergone a good alcoholic fermentation, taking care to immerse them completely. They are kept in the liquid by a cover, pierced with holes for the escape of carbonic acid set free in the course of the fermentation. But during the process it is necessary to add successively sulphuric acid in sufficient quantity to set free the vegetable acids which are combined with the alkaline bases contained in the beet; without this addition, the fermentation loses its regularity and produces lactic and other acids. If the proportions of sulphuric acid are right, all the sugar will be converted into alcohol. The amount will vary with the character of the soil that produced the beet, a calcareous soil requiring a little more than an argillaceous soil. In the case of the latter, five to five and a quarter litres of sulphuric acid may be added for 2200 kil. of beets. An excess of sulphuric acid injures the fermentation, and for this reason it should not be all added at once, but from time to time as the beets are added.

It is also important to have a constant and uniform relation between the liquid serving as a ferment and the charge of beets. This relation is 2200 kil. of beets to 43 to 45 hectolitres of fermented juice for one fermenting vat containing 80 hectolitres, or two parts of juice to one of sliced beets. When the process has once begun, it goes on with great rapidity and at the end of ten or twelve hours, the sugar in the cellules of the beets is changed to alcohol, so that the cellules contain alcohol in place of sugar. The pieces of the beets do not change form in the process, though they become somewhat less rigid; and the proportion of juice is not essentially changed, and moreover it may serve for use

* This Journal, 1853, p. 103.

several times without any addition of yeast, provided at each operation the right proportions of sulphuric acid have been added. Thus, at the great manufacturing establishment under the direction of M. Leplay at Douvrin (Pas-de Calais), the same juice has been kept in action from Nov. 1, 1854, to the end of April, 1855, and, what is remarkable, the fermentations which took place in November in twenty-four hours, required in April only ten to twelve hours. It should be said, however, that to retain this fermenting quality, he added each week a kilogram of yeast to each vat.

When in winter, the charges of beets are added, the temperature lowers, and it is necessary to restore it again by means of steam to about 25° or 26° C.

To extract the alcohol thus produced, it is only necessary to pass through the mass a current of steam. The apparatus used for this purpose is a cylinder of wood or sheet iron, similar to the black filters (filtres à noir) employed in the sugar refineries. This apparatus has above a cover hermetically closed; and an opening communicating with a worm which is cooled by water; in the lower part there is a diaphragm pierced with holes upon which the heat is thrown. Between this diaphragm and the bottom of the cylinder, there is a void space for receiving the waters of condensation which are formed during the heating of the sliced beets by steam; and in the lower part of this space there is a stop-cock for admitting steam. The steam after entering the space escapes up through the holes among the bits of beet, and heats the whole, setting free the alcohol which passes into the next layer of beets above, and so on from layer to layer, concentrating more and more as it rises through the column of beets three to four meters in height, so that in the end, alcohol of 70° to 80° is obtained. Each bit of beet and even each cellule becomes in this operation an apparatus of rectification, in which are produced the phenomena of condensation of the vapors the more aqueous, and an enrichment of the vapors the more alcoholic: the lower layers of beets thus lose finally all their alcohol, while the upper contain the alcoholic vapor in a high state of purity. The residue of the beet is a pulp retaining all the nutritious parts, even to the soluble salts of potash and soda excepting sugar, which has been turned into alcohol.

In continuing the process, several cylindrical vessels such as have been described, charged with the fermented beet, are placed one over the other, and a communication is established between them, so that the vapors which are given out from the upper part of the first will pass to the lower of the second and so on upward. To prevent the vapors breaking a way among the irregularities of the beets or along the sides, for rapid passage through, there are diaphragms pierced with holes, placed at equal distances in the column, twenty-two centimeters apart; they thus keep up a uniform pressure in the mass and compel the vapors to spread equally. These diaphragms are connected by a bar of iron, secured to the under surface, which also serves to help in lifting out the pulp, which is done at a single operation by means of a crank. The complete apparatus consists of three cylinders arranged either in a curved or straight line; one of the cylinders is always in process of being charged or discharged, while the other two are con-

nected one above the other in such a way that the first is emptying itself when the second is in distillation.

In the largest arrangement of the kind constructed by MM. Leplay and Co., the three cylinders are each 3·40 meters high and 1·42 in diameter. They contain 12 diaphragms. Each charge of a cylinder contains 2,500 to 2,800 kil. of beets. In twenty-four hours, the distillation and emptying of fourteen cylinders may be done, corresponding to 35,000 to 40,000 kil. of beets. Two such apparatuses, distilling 9 million kilograms of beets have been kept in operation at Douvrin during the last harvest. This method has been put in practice also in other parts of France and in Belgium. We have not room for more details; we add only that the residue or pulp is much sought for by those who raise cattle, and the animals eat it with avidity.

It is apparent that the principal merit in the process is in its not requiring the rasp or the press, and its obtaining the alcohol at the first nearly pure. In this way, too, the viscous, acetic or putrid fermentation is avoided, and consequently a vat charged with beets may be kept for fifteen days without loss or injury, while in the fermentation of the juice an alteration often takes place even in twenty-four hours.

Bibliography.— Visite à l'Exposition Universelle de Paris in 1855, par MM. TRESCA, PELIGOT, SILBERMANN, etc., 1 vol. in 12 mo. Paris: chez Hachette.—We have neither time nor space for describing the Exhibition at Paris; but there is here a book costing only 3 francs, giving an account of each object exhibited, and a history of each invention. The names of the authors guarantee exactness and fidelity in all facts and details.

Precis de Chemie Industrielle, par A. PAYEN, 3d edit., in 1 vol. 8vo., of 1070 pages, with an atlas. Paris: chez Hachette.—Since the publication of the first edition of this work, all the technological journals have drawn freely from its pages; for as Professor of Chemistry in the Conservatory of Arts and Trades at Paris, M. Payen is in the way to know better than any one else in France, all that relates to the newest results in industrial chemistry in his own and other countries. Two editions have successively been exhausted within a short time. The third was called for, and the Paris Exhibition has enabled the author to give it greater completeness. It contains special details upon caoutchouc, gutta percha, illuminating gas, manufacture of paper, chemical matches, starch, sugar, artificial soda, the fatty bodies, sulphuric acid, phosphorus, etc. etc.

Des Substances Alimentaires, by M. PAYEN, in 12mo. Paris: price three francs.—This work written for the people and for artisans who have little knowledge of chemistry, is especially interesting for the methods which it gives for improving articles of food, preserving them, or detecting adulterations, etc.

Leçons de Chémie générale élémentaire, par M. CAHOURS, 2 vols. in 12mo. Paris: chez Mallet-Bachelier.—These lessons are arranged after the lectures which M. Cahours delivers at the "Ecole Centrale des Arts et Metiers" as successor to Dumas. A clear, simple and methodical style characterises this small work, in which we recognise the able instructions of M. Dumas, worked up by one of the most distinguished of his students.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Effect of Chlorine in Coloring the Flame of Burning Bodies;* by D. Forbes, F.G.S., F.C.S., A.I.C.E., (L., E. and D. Phil. Mag., xi, 65.)—A considerable time back, while examining some saline minerals for boracic acid, and employing the usual test as to the power of coloring flame green, when treated with sulphuric acid and alcohol, it was found that a green flame presented itself, very similar to that which would be expected in case boracic acid were present in the minerals. On the most careful examination, however, no traces of boracic acid could be detected, and it was evident that the coloration of the flame must have proceeded from some other source.

As chlorine was present in considerable amount in the minerals in question, it became interesting to see whether its presence might have produed the green color; and the experiments made on the subject fully confirmed this view. A number of other experiments on the power possessed by chlorine to color flame, led to the following conclusions, which are stated briefly, as the results themselves sufficiently explain the *modus operandi*.

Chlorids treated with concentrated sulphuric acid and a very small amount of alcohol produced green flames similar to those eliminated from borates under like treatment. Quantitatively, however, the flames were of less intensity; that is, the same weight of a borate would produce considerably darker green flames than when a chlorid was used.

When chlorids were moistened with sulphuric acid and heated in the blowpipe flame, a faint green coloration was observed, which generally confined itself to the inner flame.

When hydrochloric acid is dropped cautiously on the flame of burning alcohol, a greenish tinge is observable.

A jet of chlorine or of hydrochloric acid gas directed upon the flame of a spirit-lamp or of coal-gas. produces a jet of green flame; this was also found to be the case when (by means of a convenient burner) chlorine gas was passed into the centre of a flame of burning coal-gas, or of vapor of alcohol.

When burning alcohol was injected into a globe filled with chlorine gas, the alcohol vapor continued burning at the mouth of the globe with a very flickering but often brilliant green flame.

From the above experiments, it will be seen that chlorine has in itself a decided coloring action on the flames of burning bodies, which may consequently in some cases lead to its being confounded with boron, as the green color imparted to flame has hitherto been regarded as a most characteristic test of the latter element. When, as often happens, chlorine and boron occur together, this test consequently becomes nearly valueless.

2. *On some points of Magnetic Philosophy;* by Prof. Faraday, D.C.L., F.R.S., (Proc. Roy. Inst. of Great Britain, Jan. 1855, p. 6.)—The magnetic and electric forms of power being dual in their character, and

also able to act at a distance, will probably aid greatly in the development of the nature of physical force generally: and if (as I believe) the dualities are essential to the forces, are always equal and equivalent to each other, and are so mutually dependent, that one cannot appear, or even exist, without the other, the proof of the truth of such conditions would lead to many consequences of the highest importance to the philosophy of force generally. A few brief experiments with the electric power quickly place the dual cases before the contemplative mind. Thus, if a metallic vessel, as an ice-pail, be insulated and connected with a delicate gold leaf electrometer, or other like instrument, and then an insulated metallic globe, half the diameter of the ice-pail, be charged with positive electricity and placed in the middle of the pail, the latter being for the moment uninsulated by a touch outside, and then left insulated again, the whole system will show no signs of electricity externally, nor will the electrometer be affected: but a carrier applied to the ball within the vessel will bring away from it positive electricity, showing its particular state of charge; or being applied to the lower inside surface of the vessel will bring away negative electricity, proving that it has the contrary state: or the duality may be proved by withdrawing the ball, when the vessel will show itself negative by the electrometer, and the ball will be found positive. That these dualities are equal, is further shown by replacing the ball within the vessel, observing the electrometer, bringing the ball and vessel in contact, and again observing the electrometer, which will remain unchanged; and finally withdrawing the ball, which comes away perfectly discharged, and leaves the vessel externally in its unchanged and previous state. So the electric dualities are equal, equivalent, and mutually sustained. To show that one cannot exist alone, insulate the metallic vessel, charge it strongly by contact with the machine or a Leyden jar, and then dip the insulated ball into it; and after touching the bottom of the vessel with the ball, remove it, without touching the sides: it will be found absolutely free from charge, whatever its previous state may have been; for none but a single state can exist at the bottom of such a metallic vessel; and a single state, *i. e.*, in an unrelated duality, cannot exist alone.

The correspondent dualities, *i. e.*, the northness and the southness of the magnetic force are well known. For the purpose of insulating, if possible one of these, and separating it in any degree from the other, numerous experiments have been made. Thus six equal electro-magnets, formed of square bars, were put together in the direction of three lines perpendicular to each other, so that their inner ends, being all alike in polarity, might inclose a cubical space and produce an experimental chamber. When excited, these magnets were very powerful in the outer direction, as was found by nails, filings, spirals, and needles; but within the chamber, walled in on every side by intense north poles, there was no power of any kind: filings were not arranged; small needles not affected, except as they by their own inducing powers caused arrangement of the force within; revolving wire helices produced no currents: the chamber was a place of no magnetic action. Ordinary magnetic poles of like nature produced corresponding results. A single pole presented its usual character, attracting iron, repelling

bismuth; a like pole, at right angles to it, formed a re-entering angle, and there a weak pole of magnetic action was caused; iron was attracted from it to the prominent corners; bismuth moved up into it; and a third like pole on the opposite side made the place of weak force still weaker and larger; another pole or two made it very weak; six poles brought it to the condition above described. Even four poles, put with their longer edges together, produced a lengthened chamber with two entrances; and a little needle being carried in at either entrance passed rapidly through spaces of weaker and weaker force, and found a part in the middle where magnetic action was not sensible.

Other very interesting results were obtained by making chambers in the polar extremities of electro-magnets. A cylinder magnet, whose core was 1·5 inches in diameter, had a concentric cylindrical chamber formed in the end, 0·7 in diameter, and 1·3 inches deep. When iron filings were brought near this excited pole, they clung around the outside, but none entered the cavity, except a very few near the outer edge. When they were purposely placed inside on a card they were quite indifferent to the excited pole, except that those near the mouth of the chamber moved out and were attracted to the outer edges. A piece of soft iron at the end of a copper wire was strongly attracted by the outer parts of the pole, but unaffected within. When the chamber was filled with iron filings and inverted, the magnet being excited, all those from the bottom and interior of the chamber fell out; many, however, being caught up by the outer parts of the pole. If pieces of iron, successively increasing from the size of a filing to a nail, a spike, and so on to a long bar, were brought into contact with the same point at the bottom of the inverted chamber, though the filing could not be held by attraction, nor the smaller pieces of iron, yet as soon as those were employed which reached to the level of the chamber mouth, or beyond it, attraction manifested itself; and with the larger pieces it rose so high that a bar of some pounds weight could be held against the very spot that was not sufficient to retain an iron filing.

These and many other results prove experimentally, that the magnetic dualities cannot appear alone; and that when they are developed they are in equal proportions and essentially connected. For if not essentially connected, how could a magnet exist alone? Its power, evident when other magnets, or iron, or bismuth is near it, must, upon their removal, then take up some *other form*, or exist *without action:* the first has never been shown or even suspected; the second is an impossibility, being inconsistent with the observation of force. But if the dualities of a single magnet are thrown upon each other, and so become mutually related, is that in right lines through the magnet, or in curved lines through the space around? That it is not in right lines through the magnet (it being a straight bar or sphere) is shown by this, that the proper means as a helix round the magnet, shows that the *internal* disposition of the force (coercitive or other) is not affected when the magnet is exerting its power on other magnets, or when left to itself (*Experimental Researches*, 3119, 3121, 3215, &c.); and like means show that the *external* disposition of the force is so affected: so that the force in right lines through the magnet does not change under the circumstances, whilst the force in external (and necessarily) curved lines does.

The polarity of bismuth or phosphorus in the magnetic field is one point amongst many others essentially dependent upon, and highly illustrative of the nature of, the magnetic force. The assumption that they have a polarity the reverse of that of paramagnetic bodies involves the consequence, that northness does not always repel northness or attract southness; or else leads to the assumption that there are two northnesses and two southnesses, and that these sometimes associate in pairs one way, and at other times in the contrary way. But leaving the assumptions and reverting to experiment, it was hoped that a forcible imitation of the imagined state of bismuth in the magnetic field, might illustrate its real state, and, for this purpose, recourse was had to the indications given by a moving conductor. Four spheres of copper, iron, bismuth, and hard steel have been prepared, and rotated upon an axis coincident with the magnetic axis of a powerful horse-shoe magnet; each sphere has a ring of copper fixed on it as an equator, and the ends of a galvanometer wire were brought into contact with the axis and the equator of the revolving globe. Under these circumstances, the electric current produced in the moving globe was conveyed to the galvanometer, and became the indicator of the magnetic polarity of the spheres; the direction of rotation, and the poles of the magnet, being in all cases the same. When the copper sphere, as a standard, was revolved, deflection at the galvanometer occurred in a certain direction. When the iron sphere replaced the copper and was revolved, the deflection at the galvanometer was the same. When the bismuth sphere was employed, the deflection was still the same:—and it still remained the same when the steel sphere was rotated in the magnetic field. Hence, by this effect, which I believe to be a truthful and unvarying indication of polarity, the state of all the spheres was the same, and therefore the polarity of the magnetic force in the iron, copper, and bismuth, in every case alike (*Exp. Res.* 3164, &c.). The steel sphere was then magnetized in the direction of its axis, and was found to be so hard as to retain its own magnetic state when in a reverse direction between the poles of the dominant magnet, for upon its removal its magnetism remained unchanged. Experiments were then made in a selected position, where the dominant magnet force was not too strong —(a magnet able to lift 430 lbs. was used)—and it was found that when the steel magnet was placed in accordance, *i. e.*, with its north pole opposite the south pole of the dominant magnet, the deflection was in the same direction as with the bismuth sphere: but when it was changed so as to be in the magnetic condition assigned by some to bismuth (*i. e.* with reversed polarities), it then differed from bismuth, producing the contrary deflection.

It is, probably, of great importance that our thoughts should be stirred up at this time to a reconsideration of the general nature of physical force, and especially to those forms of it which are concerned in actions at a distance. These are, by the dual powers, connected very intimately with those which occur at insensible distances; and it is to be expected that the progress which physical science has made in latter times will enable us to approach this deep and difficult subject with far more advantage than any possessed by philosophers at former periods.

At present we are accustomed to admit action at sensible distances, as of one magnet upon another, or of the sun upon the earth, as if such admission were itself a perfect answer to any enquiry into the nature of the physical means which cause distant bodies to affect each other; and the man who hesitates to admit the sufficiency of the answer, or of the assumption on which it rests, and asks for a more satisfactory account, runs some risk of appearing ridiculous or ignorant before the world of science. Yet Newton, who did more than any other man in demonstrating the law of action of distant bodies, including amongst such the sun and Saturn, which are nine hundred millions of miles apart, did not leave the subject without recording his well-considered judgment, that the mere attraction of distant portions of matter was not a sufficient or satisfactory thought for a philosopher. That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is, he says, to him a great absurdity. Gravity must be caused by an agent, acting constantly according to certain laws; but whether this agent be material or immaterial he leaves to the consideration of his readers. This is the onward looking thought of one, who by his knowledge and like quality of mind, saw in the diamond an unctuous substance coagulated, when as yet it was known but as a transparent stone, and foretold the presence of a combustible substance in water a century before water was decomposed or hydrogen discovered: and I cannot help believing that the time is near at hand, when his thought regarding gravity will produce fruit: and, with that impression, I shall venture a few considerations upon what appears to me the insufficiency of the usually accepted notions of gravity, and of those forces generally, which are supposed to act at a distance, having respect to the modern and philosophic view of the conservation and indestructibility of force.

The notion of the gravitating force is, with those who admit Newton's law, but go with him no further, that matter attracts matter with a strength which is inversely as the square of the distance. Consider, then, as a mass of matter (or a particle), for which present purpose the sun will serve, and consider a globe like one of the planets, as our earth, either created or taken from distant space and placed near the sun as our earth is;—the attraction of gravity is then exerted, and we say that the sun attracts the earth, and, also, that the earth attracts the sun. But if the sun attracts the earth, that force of attraction must either arise *because* of the presence of the earth near the sun; or it must have *pre-existed* in the sun when the earth was not there. If we consider the first case, I think it will be exceeding difficult to conceive that the sudden presence of an earth, ninety-five millions of miles from the sun, and having no previous physical connection with it, nor any physical connection caused by the mere circumstance of juxtaposition, should be able to raise up in the sun a power having no previous existence. As respects gravity, the earth must be considered as inert, previously, as the sun; and can have no more inducing or affecting power over the sun than the sun over it: both are assumed to be *without* power in the beginning of the case;—how then can that power arise

by their mere approximation or co-existence? That a body without force should raise up force in a body at a distance from it, is too hard to imagine; but it is harder still, if that can be possible, to accept the idea when we consider that it includes the *creation of force.* Force may be opposed by force, may be diverted, directed partially or exclusively, may even be converted, as far as we understand the matter, disappearing in one form to reappear in another; but it cannot be created or annihilated, or truly suspended, *i. e.*, rendered existent without action or without its equivalent action. The conservation of power is now a thought deeply impressed upon the minds of philosophic men; and I think that, as a body, they admit that the creation or annihilation of force is equally impossible with the creation or annihilation of matter. But if we conceive the sun existing alone in space, exerting no force of gravitation exterior to it; and then conceive another sphere in space having like conditions, and that the two are brought towards each other; if we assume, that by their mutual presence each causes the other to act,—this is to assume not merely a creation of power but a *double creation*, for both are supposed to rise from a previously inert to a powerful state. On their dissociation they, by the assumption, pass into the powerless state again, and this would be equivalent to the *annihilation* of force. It will be easily understood, that the case of the sun or the earth, or of any one of two or more acting bodies, is reciprocal;—and also that the variation of attraction, with any degrees of approach or separation of the bodies, involves the same result of creation or annihilation of power, as the creation or annihilation (which latter is only the total removal) of either of the acting bodies would do.

Such, I think, must be the character of the conclusion, if it be supposed that the attraction of the sun upon the earth arises *because* of the presence of the earth, and the attraction of the earth upon the sun, because of the presence of the sun: there remains the case of the power, or the efficient source of the power, having pre-existed in the sun (or the earth) *before* the earth (or the sun) was in presence. In the latter view it appears to me that, consistently with the conservation of force, one of three sub-cases must occur: either the gravitating force of the sun, when directed upon the earth, must be removed in an equivalent degree from some other bodies, and when taken off from the earth (by the disappearance of the latter) be disposed of on some other bodies;—or else it must take up some *new* form of power when it ceases to be gravitation, and consume some other form of power when it is developed as gravitation;—or else it must be *always* existing around the sun through infinite space. The first sub-case is not imagined by the usual hypothesis of gravitation, and will hardly be supposed probable: for, if it were true, it is scarcely possible that the effects should not have been observed by astronomers, when considering the motions of the plants in different positions with respect to each other and the sun. Moreover, gravitation is not assumed to be a dual power, and in them only as yet have such removals been observed by experiment or conceived by the mind. The second sub-case, or that of a new or another form of power, is also one which has never been imagined by others, in association with the theory of gravity. I made some

endeavors, experimentally, to connect gravity with electricity, having this very object in view (*Phil. Trans.* 1851, p. 1); but the results were entirely negative. The view, if held for a moment, would imply that not merely the sun, but all matter, whatever its state, would have extra powers set up in it, if removed in any degree from gravitation; that the particles of a comet at its perihelion would have changed in character, by the conversion of some portion of their molecular force into the increased amount of gravitating force which they would then exert; and that at its aphelion, this extra gravitating force would have been converted back into some other kind of molecular force, having either the former or a new character: the conversion either way being to a perfectly equivalent degree. One could not even conceive of the diffusion of a cloud of dust, or its concentration into a stone, without supposing something of the same kind to occur; and I suppose that nobody will accept the idea as possible. The third sub-case remains, namely, that the power is always existing around the sun and through infinite space, whether secondary bodies be there to be acted upon by gravitation or not: and not only around the sun, but around every particle of matter which has existence. The case of a constant necessary condition to action in space, when as respects the sun the earth is *not* in place, and of a certain gravitating action as the result of that previous condition when the earth *is* in place, I can conceive, consistently, as I think, with the conservation of force: and I think the case is that which Newton looked at in gravity; is, in philosophical respects, the same as that admitted by all in regard to light, heat, and radiant phenomena; and (in a sense even more general and extensive) is that now driven upon our attention in an especially forcible and instructive manner, by the phenomena of electricity and magnetism, because of their dependence on dual forms of power.

II. Geology.

1. *Description of the Fossils and Shells collected in California;* by Wm. P. Blake, Geologist of the U. S. Pacific Railroad Survey in California, under the command of Lieut. R. S. Williamson, in 1853–54. 34 pp. 8vo. War Department, Washington, 1855.—The explorations of the Rocky Mountains and Western America by the Pacific Railroad Expeditions have brought in large contributions to science in its various departments, and it is most gratifying to know that they are to be published with full details and figures. The important pamphlet here referred to gives in brief some of the geological results in anticipation of the final Report. The facts are of special interest to the science, and we cite the general conclusions.

Report of Mr. T. A. Conrad on the Fossil Shells collected in California by Wm. P. Blake.—I have examined the very interesting organic remains which you collected in California, and the drawings of such species as were too fragile to preserve, and I herein submit a few remarks upon their geological relations. There appear to be several distinct groups; but I cannot pretend, from such scanty materials, to designate what particular formation every group represents. There is no obscurity resting on the deposits of Santa Barbara and San Pedro,

which represent a recent formation, in which you inform me the remains of the mammoth occur. The shells are generally those which live in the adjacent waters, and indicate little if any change of temperature since their deposition. The littoral character of this formation is very evident. Water-worn shells and fragments show the action of the surf, whilst entire specimens of bivalves, and Pholadidæ, and Saxicavæ, remaining undisturbed in their self-excavated domicils, exhibit the same disposition of marine shells that is familiar to the observer on all sandy and argillaceous shores. They burrow in clay, mud or sand, beyond the ordinary action of the surf; whilst some are scooped out by the tempest-driven surge, and others preyed upon by fishes and marine animals of various kinds, and are thus broken up and deposited among the living species.

Of the Eocene, and the recent formation alluded to, I can speak with confidence; but the intermediate beds are of uncertain age. The *Ostrea vespertina*, *Anomia subcostata* and *Pecten vespertinus*, occurring in the bank of Carizzo creek, are unlike any recent forms that I am acquainted with from the Pacific coast, but analogous to Miocene species of Virginia. This formation may, therefore, be regarded as of Miocene origin—an opinion in which I am confirmed by some fossils collected in California, by Dr. Heermann, consisting of decidedly Miocene forms; a *Mercenaria*, (*M. perlaminosa*,) Con., scarcely differing from a species of Cumberland county, N. J., (*M. Ducatelii*, Con.), a *Cemoria*, *Pandora* and *Cardita* of extinct species, closely analogous to Miocene forms. I am inclined, also, to refer to this period a very different group from Ocoya creek, the forms of which you sketched in California, as the specimens were too friable to be preserved. I do not recognize any recent species among them, nor any contained in an Eocene deposit.

The rock at San Diego is replete with shells, generally of a small size, and appears to have a certain palæontological relation to those of Monterey, Carmello, and those from the rocks near Astoria in Oregon, collected by Townsend, and Dana, which I have referred to the Miocene period. Two species of San Diego, if not identical, approach Oregon shells; *Nucula decisa* is similar to *N. divaricata*, and both, in their markings, resemble *N. Cobboldii* of the English Miocene. *Mactra Diegoana* is nearly related to the Oregon *M. alboria*.

The Eocene period is unequivocally represented by the beautifully perfect shells from the Cañada de las Uvas, which, though not found in situ, are evidently derived from strata occurring on the Pacific slope of the Sierra Nevada. This is very remarkable, inasmuch as three species correspond with forms of Claiborne, Alabama, and seem to indicate a connexion with the Atlantic and Pacific oceans during the Eocene period. The vast distance between the two localities will account for the general distinction of species, and it was, indeed, an unexpected result to find any identical. If I had imagined any eastern species to occur in California, it would have been the very one which does occur, and, apparently, in abundance, that "finger-post" of the Eocene, *Cardita planicosta*, a fossil of the Paris basin, and also abundant in Maryland, Virginia, and Alabama. This species originated and perished in the Eocene period, and is so widely distributed that it may

be regarded as the most characteristic fossil of its era. As the boulder from which these shells were derived was quite small, and yet furnished thirteen species, when it shall be investigated in situ, doubtless a great many other forms will be obtained, and very likely some with which we are already familiar in eastern localities. Although the rock is a very hard sandstone, the shells may be exposed in great perfection by careful management, and we look forward with great interest to their further development, and to the discovery of the rock in situ.

List of Species.—[Species not new are marked with an asterisk; all are Conrad's except Natica gibbosa and Anodonta Californiensis of Lea, Cardita planicosta, and Fissurella crenulata of Sowerby.]

(1.) Eocene.—Cardium linteum, Dosinia alta, Meretrix Uvasana, M. Californiana, Crassatella Uvasana, C. alta, Mytilus humerus, Cardita planicosta,* Natica œtites, N. gibbosa,* Turritella Uvasana, Volutatithes Calforniana, Busycon ? Blakei, Clavatula Californica.

(2.) Miocene and recent formations.—Cardium modestum, Nucula decisa, Corbula Diegoana, San Diego; Meretrix uniomeris, Monterey county; M. decisa, Ocoya creek; M. Tularana, Tulare valley; Tellina Diegoana, San Diego; T. congesta, Monterey, Carmello, and San Diego; T. Pedroana, San Pedro; Arca microdonta, Tulare valley ?; Tapes diversum,* Saxicava abrupta, Petricola Pedroana, Schizothœrus Nutalli, San Pedro; Lutraria Traskei, Carmello; Mactra Diegoana, San Diego; Modiola contracta, Monterey county; Mytilus Pedroanus, San Pedro; Pecten Deserti, Anomia subcostata, Ostrea vespertina, O. Heermanni, Colorado desert; Penitella spelæum, San Pedro, (recent); Fissurella crenulata,* San Pedro; Crepidula princeps, Santa Barbara; Natica Diegoana, Trochita Diegoana, San Diego; Crucibulum spinosum, ——?; Nassa interstriata, N. Pedroana, Strephona Pedroana, Littorina Pedroana, San Pedro; Stramonita petrosa, Tulare valley; Gratelupia mactropsis, Meretrix Dariena, Tellina Dariena, Isthmus of Darien; Natica Ocoyana, N. geniculata, Bulla jugularis, Pleurotoma transmontana, P. Ocoyana, Scytopus Ocoyanus, Turritella Ocoyana, Colus arctatus, Tellina Ocoyana, Pecten Nevadanus, P. catilliformis, Cardium ——? Arca ——? Solen ——? Dosinia ——? Venus ——? Cytherea decisa? Ocoya or Posé creek; Ostrea ——? Pecten ——? Turritella biseriata, San Fernando; Trochus ——? Turritella ——?, Benicia; Buccinum interstriatum? Olivia Pedroensis, San Pedro; Anodonta Californiensis,* Colorado desert.

Remarks in conclusion, by W. P. Blake.—From this report by Mr. Conrad, we find that in the collection of sixty-one determinable species, fifty-five are new and are now described for the first time. Of these, ten are from one locality at the southern extremity of the Tulare valley, at the entrance to the pass called the Cañada de las Uvas. They are considered to be of the age of the Eocene by Mr. Conrad, who notes the similarity between three of the species and those of the Alabama Eocene deposits at Claiborne. These fossils were imbedded in a boulder of compact sandstone that had been washed out of the ravine of the pass by floods. The rock was not found *in situ* at that point, but a few miles to the westward a similar rock occurs in place, and is replete with fossils. These are believed to be the first fossils of the Eocene age that have been procured from the Pacific slope of the United States.

The sedimentary formations of Ocoya creek (Posé creek) are considered to be of the age of the Miocene, and twelve new species from that locality are described. There were numerous specimens of other species in the collection, which were not sufficiently characteristic for determination, but which are probably new. Eight new species of Miocene shells are described from San Diego, and ten of a more recent formation from San Pedro. These last occur in a bank fronting the bay, and which is partly undermined by the surf. The bank is filled with shells, and the principal stratum is about 30 feet above tide.

The fossils from the sandstones along Carrizo creek, near the point where it spreads out and is lost in the desert, are all new and of Miocene age.

The Miocene formation appears, therefore, to flank the Peninsula Sierra on both sides in the latitude of San Diego, and to underlie the alluvial deposits or delta of the Colorado. There is a remarkable difference in the appearance of the fossils on the east and west sides of this chain. Those on the desert side form a stratum four or five feet thick *of shells alone*, consisting almost wholly of the genera Ostrea, Anomia and Pecten; while on the west side, bordering the Pacific, there is a greater variety of genera and species; shells of the genera Cardium, Nucula, Corbula, Tellina, Mactra, Natica and Trochita being abundant. An interesting relationship between the existing and fossil shells of the Gulf side of the chain is indicated, and it is probable that the crest of the chain divided the waters of the Gulf and the Pacific during the Miocene era.

At the pass of San Fernando, between Los Angeles and the granitic mountains, the sandstone strata contain numerous fossils, and fragments of shells belonging to the genera Ostrea, Pecten, and Turritella were procured. These, being imperfect, have not been specifically described by Mr. Conrad.

At Navy Point, Benicia, I obtained several casts of shells in an imperfect state, and, also, a small shark's tooth. The shells were probably of the genera Trochus and Turritella. Numerous specimens of lignite were also found at that place, imbedded in the compact sandstone.

At San Francisco, on the west side of the peninsula, near the lagoon on the beach, numerous specimens of fossil Spatangi are thrown up by the surf. They are inclosed in a matrix of bluish-green sand, resembling in color and composition the blue sandstone of the bay. It is, however, more friable, and seems to consist of the debris of the strata.

The town of Monterey is built over the line of junction of the granite of Point Piños, with an extensive series of tertiary strata, remarkable for containing immense deposits of the remains of Infusoria. These remains form white beds of siliceous earth, intercalated with semi-opaline strata of a very compact texture. They are now upraised nearly 500 feet above the water of the bay. Portions of the underlying strata—those in which the *Tellina congesta*, Con., occurs so abundantly—are also charged with small chambered shells, (Foraminifera of D'Orbigny,) and offer a rich treat to the micro-geologist. With the aid of a glass thousands of these little shells can be seen on the fractured surfaces of the rock.

From this report, and the preceding remarks, it will be seen that fossils in sufficient numbers to determine the geological age of the deposits in which they occur have been obtained from many and distant points on the Pacific coast.

The occurrence of Eocene strata at one point has been satisfactorily established. We also find that the Miocene division of the tertiary formations is extensively developed, over broad areas, in California, flanking nearly all the great lines of elevation, not only in the coast mountains, but in the interior, along the borders of the San Joaquin and Tulare valleys. Further observations are required to connect, chronologically, the Miocene deposits along Ocoya creek with the extensive, and in many respects similar, strata further north, along the Tuolumne and Stanislaus rivers.

Notice of the Fossil Fishes found in California by W. P. Blake; by L. Agassiz.—Most of the fossil remains of fishes placed in my hands by Mr. Blake for examination and identification belong to the family of sharks, one belongs to that of skates, and another is remotely allied to the family of mackerels. No fossil sharks' teeth having been found west of the Rocky mountains before; the discovery by Mr. Blake of a variety of species belonging to several genera of the family of sharks constitutes one of the most interesting additions to our knowledge that could have been obtained from that quarter, and the importance of these fossils to science is further enhanced by the peculiar relations they bear to similar fossils found in the Atlantic states and in Europe and to the sharks now living along the shores of the old and of the new world.

(1.) *Echinorhinus Blakei*, Agassiz.—One of the most interesting and important discoveries since the publication of the "Poissons Fossiles" is that of the tooth of the genus Echinorhinus, in the tertiary deposits of Ocoya creek (Posé creek), at the western base of the Sierra Nevada, California. The genus Echinorhinus was founded by Blainville for the *Squalus spinosus* of Linnæus, the only species of the genus thus far known which inhabits the Mediterranean and the European and African coasts of the Atlantic.

I figured the teeth of the same genus under the name of Goniodus for the same species, (see *Poissons Fossiles*, vol. iii, p. 94, pl. E, fig. 13,) so that this name must give way to the Echinorhinus of Blainville.

The discovery of a fossil species of this genus in the tertiaries of the western slope of the Sierra Nevada is not only important as carrying back this curious type of sharks to a period older than ours, but also in disclosing the existence upon the American continent of types in a fossil state known in the old world only among the living. The fossil species of Echinorhinus differs from the living, having the main point of the tooth more prominent, and at the same time shorter, an appearance which arises from the less prominence of the marginal denticles. This difference may be distinctly seen by comparing the figures with those of the living species given in Poissons Fossiles, pl. E, fig. 13.

(2.) *Scymnus occidentalis*, Agas.—The few species upon which Cuvier founded the genus Scymnus have been of late subdivided by Müller and Henle into two genera: Scymnus proper, and Læmargus; all of which are only known among the living. It is another of the highly interesting discoveries of Mr. Blake, to have brought home two teeth

from the tertiaries of California belonging to this remarkable type. I would even not hesitate to consider them as indicating a distinct genus, were the number of specimens sufficient to warrant the inference that the teeth present, in every position of the mouth, as great a difference from the Scymnus and Læmargus as the two latter present when compared with one another. At all events, the teeth belong to the genus Scymnus, as established by Cuvier, and it constitutes a very distinct species on account of the strong bend backwards of the main point of the tooth, and the distinct and rather marked serration of the edges of the crown. Moreover, the inclination of the central point upon its basis gives these teeth a certain resemblance with those of Spinax and Centrophorus, and still more with Galeocerdo. The connexion of the teeth of the same row of the jaw with one another, was evidently the same as in the Scymnus and Læmargus, as is plainly shown by the notch upon the inner surface of the root, and the articulating tubercle at the base of the enamel in both sides.

The discovery of a fossil Scymnus in the tertiaries of California is particularly interesting in a geographical point of view since thus far no representative of the type has been found in the Pacific ocean.

(3.) *Galeocerdo productus*, Agass.—Two species only of living Galeocerdo have been known thus far—one from the Indian ocean and one from the Atlantic. The fossil species have been traced from the chalk to the upper tertiaries.

The Atlantic States have already yielded satisfactory indications of the presence of this genus during the tertiary period, on the eastern coast of America. Now we receive from the collection of Mr. Blake a new addition to the range of this remarkable genus. The new species he has discovered resembles so closely the Galeocerdo aduncus from the Eocene of Europe, especially common in the Molasse of Switzerland, that were there not several specimens in the collection agreeing with one another in every respect, and unitedly differing from those in the Old World, I should have been at a loss to distinguish them. The California species differ from the European chiefly in having the anterior margin of the tooth less arched, with much more minute crenulations, and the serratures on the basilar margin rather smaller.

(4.) *Prionodon antiquus*, Agas.—Thus far no fossil shark of the tribe of *Carcharias* has been known among the fossils, and as shown in the Poisson Fossiles, all the species formerly referred to the genus Carcharias have been ascertained to belong to the genus Carcharodon. Few discoveries in this field, therefore, could be of more interest than finding among the tertiaries of Ocoya creek a number of teeth agreeing in the deep notch upon the base of the root, but differing in their width as well as in the shape of their edge; belonging evidently to the genus Prionodon of Müller and Henle. The larger and broader ones have the edges serrated, especially near the base, while the narrower ones are smooth and sharp. These differences correspond exactly to the differences observed by Müller and Henle between the teeth of the upper and lower jaw in some species of the genus Prionodon. A transverse section of the fossil under consideration, moreover, shows these teeth to have a central cavity, as in those of the whole tribe of Carcharias. There can, therefore, be no doubt that we have here the first

instance of a fossil species of the type of Carcharias of the genus Prionodon, which it will be possible, under all circumstances, to distinguish from Sphyrna by the difference in the shape and serrature of the teeth in the upper and lower jaw. The species may be designated *Prionodon antiquus.*

My *Galeocerdo denticulatus*, from Maestricht, may, however, belong to this genus. The tooth of this species being rather erect, while in Galeocerdo the crown of the tooth is bent backwards, and its posterior margin is deeply notched. In *Prionodon antiquus*, as well as in *G. denticulatus*, the crown is but slightly inclined backwards, and though it tapers rapidly to a conical point, that point does not stand so distinctly out from its base as in true Galeocerdo.

(5.) *Hemipristis Heteropleurus*, Agas.—The genus Hemipristis was established by me from fossil teeth of the middle tertiaries of Europe. Dr. R. W. Gibbes has since indicated their existence among the tertiaries of the Atlantic shores of America, and now we owe to Mr. Blake the discovery of a tooth of this genus in the deposits of Ocoya creek, California.

I have already remarked how difficult it is to perceive the difference existing between Galeocerdo aduncus of Europe, and the species of that genus existing in California. I am still more doubtful about the propriety of distinguishing the species Hemipristis of the west from those of Europe. It would seem extraordinary, however, to find the same species of sharks extending from the Pacific coast of this continent to central Europe, especially when we find, upon closer examination, our living sharks more closely circumscribed within narrow limits than was formerly supposed. And yet all the differences I perceive between the Hemipristis of California and those of Europe consist in a marked inequality between the serrature of the hinder margin when compared with that of the anterior margin of the tooth. As this may be found to be a constant character, I would introduce the western species provisionally, under the name of *H. heteropleurus*, or until the discovery of more specimens decides whether this difference in the serrature of the margin of the inner sides of the teeth is constant or not.

(6.) *Carcharodon rectus*, Agas.—Of all the types of sharks' teeth that of Carcharodon, next to Lamna and Oxyrhina, is the most numerous in the tertiary deposits, though there is only one living species known.

Mr. Blake has brought a finely preserved specimen of a medium sized species of this genus from California. Rather smaller than *Carcharodon angustidens*, the tooth has the same form as in that species, only there are no accessory points upon the sides of the base. Considering its size, this tooth is remarkable for its thickness, and in that respect it reminds one more of *Carcharodon angustidens* than any other species. The surface is flat and the tooth straight, as in *C. angustidens*, and to this character the name *rectus* is intended to allude.

Several species of this genus have been described by Dr. R. W. Gibbes as occurring in the tertiary of the Atlantic slope.

(7.) *Oxyrhina plana*, Agas.—Since the teeth of Oxyrhina are known to differ in size so widely as they do in different parts of the jaws, nothing is more difficult than to combine fossil teeth found separated in such a manner as to leave no doubt about their specific identity.

Several teeth of a very interesting species of Oxyrhina are found among the specimens of fossils brought by Mr. Blake from California, and its resemblance to the O. —— of the Mediteranean is very striking. But the character by which they differ most strikingly from the living species and the fossils already described consists in the greater flatness of the teeth as compared with their width. Some of them are straight, and others slightly bent backward. This species I propose to name *O. plana.*

Several species of this genus have been described from the Atlantic States by Dr. R. W. Gibbes.

(8.) *O. tumula*, Agas.—The existence of a second species of the genus Oxyrhina in the tertiary of California is indicated by several teeth remarkable for the size and thickness of the roots as compared with the lengths of their curves. The specimens agreeing in this character differ greatly in size, and yet not more so than may be seen in the same jaw of our living species.

Found with the preceding by Mr. Blake.

(9.) *Lamna clavata*, Agas.—Two teeth from Ocoya creek indicate the existence in California of a species of Lamna allied to *L. cuspidata* of the European Miocene, from which it differs, however, by its smaller size, its shorter and narrower crown, in which respect it agrees more with *L. Hopei* of Sheppy. The crown, however, is less arched than the latter. The posterior surface is smooth as in *L. cuspidata.*

Found with the preceding in the tertiary formation of Ocoya creek.

(10.) *L. ornata*, Agas.—A second species of Lamna has been brought from California by Mr. Blake. It occurs in the sandstone of Navy Point, Benicia, and is allied to *L. elegans*, Agas. (See Recherches des Poissons Fossiles, vol. iii, p. 289.) It is, however, a smaller species, and tapers more gradually, while in *L. elegans* it tapers more suddenly near the top, and the folds of the enamel on the inner side of the tooth are coarser. The base of the tooth is more compressed than in *L. elegans*, in which respect the tooth resembles more *L. acuminata.*

The small tooth found with the specimen may be one of the lateral teeth of the same species; but it is difficult to determine this without a microscopical examination of its structure. These fossils are unquestionably of tertiary age. *L. elegans* is found in the Calcaire grossier in the environs of Paris, and in the London clay at Sheppy. The same species is also found fossil in the Crag, having been transported with the remains of many other species from the London clay. Several species of this genus have been described from the Atlantic States by Dr. R. W. Gibbes.

(11.) *Zygobates*, ——?—A fragment of a tooth of the genus Zygobates is interesting inasmuch as it shows that this genus of the order of the family of skates, with pavement-like teeth, to have occurred in California during the tertiary period; though the fragment of the tooth before me is too imperfect to allow the species to be identified. It may not be out of place to remark that no species of this genus, or the allied genera Rhinoptera, Ætobates, or Myliobates have thus far been found in the Pacific ocean.

Several fragments of bone found with the teeth at Ocoya creek (Posé creek) belong to the family of Scomberoides, but are too imperfect to admit of being identified.

2. *On the Relations of the Crystalline Rocks of the North Highlands to the Old Red Sandstone of that Region, and on the Recent Fossil Discoveries of Mr. C. Peach;* by Sir RODERICK I. MURCHISON, (Proc. Brit. Assoc., 1855, Ath., No. 1457).—Having referred to his earliest publications relating to the Old Red Sandstone, in 1826 and 1827 (being associated in the latter year with Prof. Sedgwick), the author explained how the classification originally proposed by his colleague and himself had been extended and improved by the researches of Mr. Hugh Miller. Having stated that his matured and condensed views as to the true equivalents of the Old Red Sandstone being the Devonian rocks of other countries were given in his last publication, entitled 'Siluria,' Sir Roderick called the special attention of the Section to the consideration of the true relations of these deposits to the crystalline rocks of the Highlands. To satisfy his mind on this point, and to see if it was necessary to make any fundamental change in his former views, the author has spent the last five weeks in re-surveying his old ground in Sutherland, Caithness, and Ross-shire, on which occasion he was accompanied by Prof. James Nicol. Obtaining ample evidence to induce him to adhere to his former opinion, that all the crystalline rocks of that region, consisting of gneiss, mica schist, chloritic and quartzose rocks, limestones, clay slate, &c., were originally stratified deposits, which had been crystallized before the commencement of the accumulation of the Old Red Sandstone, he first gave a rapid and general sketch of those ancient rocks, whose crystalline character he thus attributed to a change, or metamorphism, of their pristine sedimentary condition. They have a prevalent strike, varying from NE and SW to NNE and SSW, and in the northernmost counties of Scotland their prevailing inclination is to the ESE or SE, usually at high angles. In combating a theoretical idea, which had only very recently been applied to the crystalline rocks of Scotland, viz., that their apparent layers were simply a sort of crystalline cleavage, by which the different minerals were arranged in parallel folia or laminæ, and were independent of the original lines of deposit, he showed how every geologist who had long studied these rocks in Scotland had formed an entirely different opinion. Hutton, Playfair, Hall, Jameson, M'Culloch, and Boué, all believed that the variously constituted and differently colored layers of these rocks truly indicated separate original deposits of sand, mud, and calcareous matter. He cited numerous cases of interstratified pebble beds and limestones as completely demonstrative of their true original status. Alluding to the real distinction between stratification and cleavage, as first defined by Prof. Sedgwick, he expressed his belief that, whilst in no part of the Highlands did there exist that perfect and symmetrical fine crystalline cleavage which prevails in North Wales (the thick slates of Ballyhulish and Easdale usually cleaving in coincidence with the laminæ of deposit), there was, nevertheless, a very marked and prevalent division of all such crystalline rocks into rhombic and other forms by rude cleavages and very decisive joints.

In describing two traverses which he made across the direction of these crystalline rock masses in the north coast of Sutherland,—the first, twenty-eight years ago, with Prof. Sedgwick, the other, in the weeks preceding this meeting, with Prof. Nicol,—and, in mentioning

with due praise a memoir, of intermediate date, by the late Mr. Cunningham, it was stated, that the oldest, or lowest, visible stratified rock in that region was a very hard, gray, quartzose gneiss, traversed by veins of granite, as seen on the shores of Loch Laxford, Cape Wrath, the escarpment of Ben Spionnach, in Durness, and other places. At the last-mentioned locality, and near Rispond, the older gneiss is unconformably overlaid by a copious series of quartz rocks, of white and grey colors, occasionally passing into mica schists or flagstones, and, also, into stratified masses, which are truly gneiss, inasmuch as they are composed of quartz, mica, or feldspar. With a copious interstratification of bands of limestone, near their lower parts, these crystalline rocks are very clearly exhibited between Loch Durness and the Whiten Head on the coast, or between Ben Spionnach and Loch Eribol, in the interior. It is in one of the beds of limestone subordinate to the lower white quartzites of this great series, some courses of which range into Assynt, in south-west Sutherland, and to Gairloch, and Kishorn, in Ross-shire, at Balnakiel, in Durness, that Mr. Charles Peach recently discovered organic remains; and, as their discovery has led to certain suggestions, including one which would consider these crystalline rocks as the representatives of the Devonian or Old Red Sandstone formation, the author begs to show why such an opinion seems to be untenable, and to point out that, both from their physical position and the nature of the imbedded remains, they are most probably of Lower Silurian age. For, whether the section be made across the various strata between Loch Durness and Loch Eribol, or from the latter to Loch Hope, the same limestones subordinate to quartz rocks of white and grey colors (including some rare coarse white grits, as in the summit of Ben Spionnach), and associated with many siliceous concretions (of various colors, red and dark grey) are distinctly and conformably overlaid by and pass up into micaceous quartzite and dark colored schists, both chloritic and talcose, which are followed by other and differently composed stratified masses, having the character of gneiss. Along the north coast these overlying masses extend to the west shore of Loch Tongue, before they are interfered with by any mass of granite; and it is, therefore, unquestionably true, that the band of limestone containing the fossil shells discovered by Mr. Peach is one of the lowest members of this great crystalline series of stratified rocks of very diversified characters. It was suggested that the fossils in question being of a whorled or circular form might prove to be the Clymenia of the Devonian rocks; but this suggestion is now set aside by Mr. Salter, who, after a close examination of the fossils submitted to him by Sir Roderick Murchison, has unreservedly expressed his belief that they are not chambered shells, and cannot, therefore, be either Clymenia or Goniatites. Mr. Salter suggests that they much resemble the Lower Silurian genus Maclurea, with which, however, they cannot be identified, as it is a sinistral shell, whilst the Durness fossil is dextral; and, on the whole, he is disposed to refer them to the genus Raphistoma, a shell which has been found in the Lower Silurian limestones of Ayrshire, (Girvan). So far, therefore, as the fossil evidence goes, it is in accordance with the geological succession of the region, and countenances the idea expressed some years ago by Prof. Nicol and the

author, that many of the stratified crystalline rocks of the Highlands would prove to be the metamorphosed equivalents of the fossiliferous Lower Silurian rocks of the south of Scotland.

Sir Roderick adverted to a feature in the older series of crystalline rocks of the west coast of Scotland, which still required to be more accurately defined than had hitherto been done. Prof. Sedgwick and himself had formerly called attention to the occurrence, near Ullapool, of a red conglomerate coarse grit, subordinate to the crystalline rocks, but which must not be confounded with the true Old Red series, as developed on the north and east coasts of the counties of Caithness, Ross, Inverness, Nairn, Moray, &c. During his excursion of this year, Prof. Nicol and himself saw, near Inchnadampff, in Assynt, a similar interposition of hard red conglomeritic grit, resting at once unconformably in the older gneiss; but bad weather prevented their ascertaining whether this mass, as exposed on the road to Loch Inver, is really surmounted by the quartz rock; nor were they able to determine the relations of the great red conglomerates of the mountains of Coul More, Sulvein, Coulbeg, and Canish, to their ancient red rock. He pointedly cautioned young Scottish geologists not to be led away by the notion, that all conglomerates made up of crystalline pre-existing rocks represented the so-called *old red* conglomerate, and particularly referred to the coarse red conglomerate of Girvan in Ayrshire, which Prof. Nicol and himself had shown to be a part of the Lower Silurian series of the south of Scotland. Whilst, however, it is probable that the red conglomerate of the West Highlands, which is associated with the series of crystalline rocks, may be also of Lower Palæozoic age, it is clear that even on that account the stupendous masses of red sandstone which constitute the mountains of Applecross and Gareloch are unquestionably of a younger date. Positive proof of this was formerly given by Prof. Sedgwick and himself from unconformable junctions of the two classes of rock in the West Highlands at Ullapool, and on the eastern coasts also, where the oldest conglomerate and sandstone of the Old Red or Devonian age of Caithness, clasps round the quartzose and micaceous rocks of the Scarabin Hills, and is made up of the materials derived from those crystalline rocks which are contiguous to it. He then expressed his firm conviction, that, from the immense length of time which must have passed in its accumulation, the vast deposits called the Old Red Sandstone were the full and entire equivalents of the Devonian rocks of the south-west of England, and of the Rhenish provinces, and of large portions of other parts of Germany, as well as of France, Spain, and other countries. He strongly insisted on the fact, that in Russia, where he had traced such a very extensive range of rocks of this age, regularly interpolated between the Silurian and Carboniferous systems, there occurred a mixture of the same species of fossil fishes (*Asterolepis*, *Dendrodus*, *Glyptosteus*, *Bothriolepis*, *Holoptychius*, *Cricodus*, *Plericthys*, &c.) which prevail in the north of Scotland, with the shells which characterize the formation in the slates and calcareous type which it assumes in Devonshire. He then announced that, in addition to the fossils previously elaborated and described by Mr. Hugh Miller and other authors, a number of plants had recently been discovered, chiefly by Mr. C. Peach, of Wick, but also

by Mr. J. Miller and Mr. Dick, of Thurso, in the very heart of the Caithness flagstones—the great fossil Piscaria of the series. Of these plants, the large number of which Mr. Peach had submitted to him seemed to be of terrestrial origin, he hoped to obtain an account at a future period from Dr. Joseph Hooker, whom he had requested to write a decade upon them in the 'Memoirs of the Geological Survey of the British Isles.' The importance of correctly determining the character of these plants will be at once seen when it is considered that, with the exception of the minute and rare vegetable forms detected by the author in the uppermost Silurian rocks, which form a passage into the Devonian rocks or Old Red Sandstone, these Caithness fossils are probably the oldest known and clearly recognizable land plants; it being believed that the fossil vegetables hitherto found in the so-called Old Red, chiefly occur in the upper meshes of the system.

Such are certain plants discovered by Dr. Fleming and others in Shetland and Orkney, by the geological surveyors in Ireland; and such is the position of the very remarkable and beautiful Flora, detected by Mr. Richter of Sahlfield, in Germany, and which he alluded to last year, as being under the description of M. Unger, the celebrated fossil botanist of Gratz. The singular plant, however, formerly described by Mr. Hugh Miller as occurring in the Cromarty strata, must be considered to be of quite as old a date as the Caithness plants.

In recapitulating, Sir Roderick called special attention to the system of the older crystalline or metamorphic rocks, and expressed his conviction that the same series was several times repeated in the contiguous tracts of Sutherland and Ross by great heaves of the masses,—such breaks being marked by the chief lochs or friths. He also dwelt on the very remarkable fact, that in these two northern counties there was an apparent symmetrical succession from older to younger masses in proceeding from the west to the east coast. Even the physical watershed of one portion of the region, as seen in the steep precipices of the Balloch of Kintail, only four miles distant from the western salt water of Loch Duich, indicating no anticlinal; the flagstones of gneissose rocks plunging rapidly to the east-south-east, a feature which was as forcibly presented in many places to the recent observation of Prof. Nicol and the author as it was to the latter and his former associate Prof. Sedgwick. Where these ancient rocks are developed in the more southern portions of the Highlands, and where they usually still preserve the same general strike from northeast to southwest as far north-north-east to south-south-west, their dips are, however, frequently anticlinal, owing to the powerful intrusion of massive igneous eruptive rocks: so that from Fort William or Ben Nevis southwards we have first in the porphyry of that mountain, and afterwards in the porphyries and syenites of Glencoe or the granite of Ben Cruachan, as well as in other points still farther south, great centres of disturbance by which the same series of quartzose, micaceous, and chloritic rocks with limestones, and in which clay slate more prevails than in the north, is repeated in vast undulations, some of which dip to the west-north-west and others to the east-south-east. One of the most southern of these anticlinals may be seen in the centre of Loch Eck, where the masses dip off to Strachur and Inverary on the northwest, and to the Clyde on the southeast.

In conclusion, the author enforced his view of the posteriority of the Old Red Sandstone to all such crystalline rocks by showing (as indeed Prof. Sedgwick and himself had done many years ago) that the coarse conglomerates of the Old Red Sandstone series, not only wrapped round those ancient rocks, but were absolutely made up of their fragments, and are seen in many places distinctly to overlie them, as at Loch Ewe, Gairloch, Applecross, &c. He further adverted to the great diversity of the strike and dip of the two classes of rock and of their entire unconformity to each other, of which he cited an instructive example at the head of Loch Keeshorn, where the lofty massive mountains of the Old Red Sandstone of Applecross, the beds of which had a steady, slight inclination of 10° or 12° to the northwest, whilst the low flanking and conterminous primary limestones, quartzites, mica schists and gneissose rocks extending from Keeshorn to Loch Carron plunge rapidly to the east-south-east. In short, whilst the limestone of Durness in Sutherland (identical in all its mineral characters and associations with quarzites with that of Keeshorn in Ross) is of very remote antiquity, and is probably, from its fossils of Lower Silurian age, the base of the Old Red Sandstone, forms a great belt composed of the regenerated materials of such older rocks, and distinctly overlies in a transgressive position the pre-existing crystalline rocks on the west, north, and east coasts of the Highlands. Referring in conclusion to the labors of Mr. Page, who had been zealously endeavoring to bring the Scottish Palæozoic classification into accordance with that of England, the author remarked, that, in respect to the position of the English "Tilestones" there existed no sort of ambiguity. These "tilestones" constitute a thin zone which exhibits in many places a mineral transition for the Upper Silurian rocks into the base of the Old Red or Devonian series, and in which we found one species of a fossil fish which occurs in unequivocal Old Red Sandstone, thin shells which range through the Ludlow rocks. They also contain forms of a remarkable genus of Crustaceans, the Pterygotus, which is known in the Arbroath paving-stones of Forfar. If, indeed, the Scotch grey pavingstones should prove to be the true representatives of the English tilestones (the species of Pterygotus of each being identical), and that it be truly shown that the great conglomerate on the flanks of the Grampians underlies such Arbroath flagstones, then it will probably follow that a great coarse angular conglomerate of the Highlands, or at least part of it, represent in time some portion of the Upper Silurian rocks. With his present amount of knowledge, however, the geologist must believe that in this part of the Scottish Palæozoic succession there is a great hiatus, since no suite of organic remains hitherto discovered has shown the presence of the Ludlow and Wenlock or Upper Silurian rocks, as exhibited in England, Sweden, Norway, Bohemia, and North America.

3. *Description of the Mineralogical Cabinet of the Garden of Plants at Paris;* by M. J.-A. HUGARD, Assistant to the Professor of Mineralogy. 12mo, pp. 190. Paris, 1855.—This admirable guide to the mineralogical museum of France, deserves to be made known to the cultivators of mineralogy who never expect to make use of it in examining the collection itself, for which it was expressly prepared, inasmuch as

the felicity of its execution renders in no small degree a model for all similar undertakings.

The first part of the work is historical; the second descriptive. Under the former head we have an account of the origin of the collection; of its gradual growth to the present day; of the succession of Professors; of the extent of the geological and mineralogical cabinets, and of the mode of cataloguing and ticketing adopted in the museum. Under the descriptive part falls first, a description of the building devoted to the reception of the collections and the general manner according to which they are distributed. In this manner thirty pages are occupied, and then commences a more detailed description of the most interesting objects in the mineral collection beginning with the different glazed cases which contain the specimens, disposed in a systematic order around the sides of the most splendid gallery devoted to this purpose in the world. The contents of one hundred and ninety-two distinct cases or compartments are noticed between pages 31 and 154. The remainder of the work is devoted to the geological collection, which occupies side-galleries on the second floor of the edifice, that communicate with the lower floor or the mineral-cabinet proper by eight flights of stairs.

We cite only a few details from the work as likely to interest American mineralogists.

It was about the year 1750 that the mineral collections under the supervision of Buffon and Daubenton were first separated from other objects of natural history and arranged by themselves. In 1772, a considerable collection was given to Buffon by the king of Poland. This was immediately added to the cabinet. From 1777 to 1785, Dombey collected with a view to its increase, in Mexico, Chili and Peru. It was he who first sent home the Atacamite, the Euclase and the Nitre of Peru. The Emperor Joseph II. of Austria presented in 1784, a splendid series of the minerals from Hungary and Transylvania; and the Empress Catharine II. of Russia in the year following, did the same, in respect to those of her vast territory. From 1770 to 1800, Dolomieu collected a magnificent series of the rocks and minerals of Portugal, Sicily, of the Alps, the Grisons and of Tyrol, which together with the fine cabinet of Faujas de St. Fond (formed among the extinct volcanoes of Viverais and Auvergne), fell to the royal collection at the Garden of Plants. It was farther enriched in 1795 by receiving the cabinet of Stathouder. In 1796, the government added a rich collection of precious stones, which had previously been deposited at the mint. The king of Denmark presented some valuable specimens in 1800. The cabinet was much enriched from 1800 to 1806, by voyages of discovery in the east. In 1802 the Garden purchased the fine cabinet of 1600 specimens of Prof. Weiss, (now of Berlin,) to the accumulation of which he had devoted twenty years of diligent labor. Then followed in succession the following valuable additions: 1, (1802 to 1808) the collection of Geoffroy St. Hilaire, remarkable for its diamonds and topazes from Brazil; 2, (1810 to 1825) collections from the king of Sweden; 3, (1823) additional specimens of value from the mint; 4, (1815) splendid specimens from Italy and Germany presented by the Emperor of Austria; 5, (1826) the king of France presented

his private cabinet; 6, (1835) the valuable collection of Gillet de Laumont consisting of 4000 specimens, was purchased; 7, (1836) the School of Mines at St. Petersburg presented a very choice collection of Russian Minerals; 8, the celebrated cabinet of 8000 specimens, formed by the Abbé Haüy was purchased in England of the Duke of Buckingham and added to the museum; 9, (1855) a splendid collection of Russian minerals which in 1853 had been presented by the Emperor Nicholas to the Institute of France, and which embraced a very precious series of emeralds, topazes, malachites and native gold.

The mineralogical catalogues number as high as 27,000 specimens. In the year 1829, Cordier was made professor of geology in the museum. The collection in this department then contained scarcely 1200 specimens of rocks of all sizes, the most of them without localities, and about 300 specimens of fossils. The collection now contains 175,000 specimens of rocks, without including detached organic fossils, of which the number exceeds 23,000 specimens, or trays often containing numerous individuals. M. Hugard very well observes, "*Ces chiffres sont assez éloquents pour montrer l'importance de la collection de geologie actuelle.*"

When the traveller from the United States views the extent of this vast museum of mineralogy and geology, and contemplates the system with which it is disposed and the care with which it is preserved, a feeling of mortification is sure to be felt, at the thought that his own great and flourishing country has nothing of the kind to show wherewith to excite the pride and study of her ambitious and intelligent sons.

S.

III. Botany and Zoology.

1. *Synopsis Plantarum Glumacearum; auctore* E. G. Steudel. Stuttgard. 1854-5. Imp. 8vo. 2 vols. in one. Pars I, *Gramineæ.* pp. 474. Pars II, *Cyperaceæ, Restiaceæ, Eriocauloneæ, Xylideæ, Desvauxieæ et Junceæ.* pp. 348.—We have noticed already the earlier fascicles of this work, now brought to a completion. The bringing together in one volume all the genera and species of Glumaceous plants, scattered through a vast number of books, is an undertaking which was much needed, and which has been faithfully done by our author, so far as we know. That he should collate and thoroughly revise the characters and rectify the synonymy was not to be expected, nor is it desirable that such a task should be attempted by any botanist resident in a German provincial town, remote from all the great herbaria. Kunth, who published the last Agrostographia and Cyperographia, possessed better means and greater experience; but his work did him little credit. If Steudel had confined himself to compilation, he would have conferred an unalloyed benefit. Unfortunately, he has described as new species several hundreds of specimens, in his own and some other herbaria, most of which doubtless belong to species already published, and which figure in his pages, each perhaps under several names besides the new ones. As a contribution to science, therefore, this work is worse than Kunth's Agrostographia;—and that is saying a great deal. A. G.

2. *Flora of Tasmania;* by JOSEPH DALTON HOOKER, M.D. Part I, 1855. Royal 4to, 80 pages, with 20 colored plates.—The labors of assorting and distributing the vast Indian herbarium formed by Dr. Thomson and himself, and of publishing the first volume of the *Flora Indica* (noticed in our last number) have not prevented Dr. Hooker from proceeding to print his Flora of Tasmania, almost as soon as that of New Zealand was completed. The letter-press of this first part comprises the orders from *Ranunculaceæ* to the commencement of *Leguminosæ*. Noteworthy points are, the transference of *Monimiaceæ* (including *Atherospermeæ*) to the same group of orders with the Magnoliaceæ, for satisfactory reasons, assigned in the Flora Indica: the union of *Mniarum* with *Scleranthus:* the detection of our *Elatine Americana*, or of a plant which Dr. Hooker cannot distinguish from that species, in Van Diemens Land: and the identification of a considerable number of Tasmanian species with those of other widely distant parts of the world. A. G.

3. *Flora van Nederlandsch Indië, door* F. A. W. MIQUEL. Amsterdam, 1855.—Prof. Miquel, one of the most active and learned of Dutch botanists, has commenced a general Flora of the Netherland's East Indian possessions, of which two parts have reached us: viz.—336 pages royal 8vo, and with 4 plates, from drawings by Ver Huell. The specific characters and technical descriptions are in Latin; the rest of the letter-press in Dutch. The work begins with the Leguminosæ, and these two parts do not complete that large order. From the author's well known industry and perseverance we may expect the publication to proceed somewhat rapidly, and that it will be executed in a very creditable manner. A. G.

4. *The Micrographic Dictionary, a Guide to the Examination and Investigation of the Structure and Nature of Microscopic Objects;* by Dr. GRIFFITH and Prof. HENFREY, published by Van Voorst, to which we have called attention during its issue, is now completed in seventeen fasciculi. It makes a stout 8vo volume of about 750 pages, including the Introduction, illustrated by 41 plates, and 816 wood-cuts; and it contains an amount of well-digested and authentic information upon the wide variety of subjects it is devoted to, which is nowhere else to be found in any one work or set of works. We find it an admirable volume for reference. The articles on the subjects we are familiar with are correct and well worked up as far as they go; and the bibliographical citations at the end of each considerable article direct us to the best and latest sources of fuller information. But it is to the general student or amateur of natural history, and to the medical student, who can rarely be expected to possess a general scientific library rich in works of original investigation, that this volume will be invaluable; and to these we cordially commend it. A. G.

5. *Algarum Unicellularium Genera Nova et minus Cognita; præmissis observanibus de Algis unicellularibus in Genere;* auct. ALEX. BRAUN. pp. 111, tab. 6, 4to. Leipsic. Engelmann. 1855.—One-celled plants, being the simplest form of vegetation, are of great interest in a physiological, and also in a morphological and systematical point of view. Prof. Braun has long been particularly conversant with these simple plants, and his writings upon the subject will command the great-

est attention. A complete history of them would form one of the most interesting treatises in the whole range of natural science, and would touch upon most of the important questions discussed at the present day, as to the nature, origin and propagation of cells, the limits of vegetable and animal life, and as to what constitutes the individual in plants. Prof. Braun's little treatise is an important contribution to this subject, although he illustrates only six genera. In the introduction he gives his general views upon the one-celled Algæ, their limits, systematic arangement, &c.

We notice also, that, in sketching the outlines of the grand divisions of the vegetable kingdom, considered as to their grade of evolution, Prof. Braun adopts Brongniart's view,—towards which there has been for some time a general tendency—claiming for the Gymnospermous Phanerogamia the position of a class, of equal rank with the common Dicotyledons and Monocotyledons combined. No new reasons for this, however, are adduced. This point is one likely to be contested, and which now demands a thorough discussion. A. G.

6. *On some specimens of deep sea bottom, from the sea of Kamtschatka, collected by Lieut. Brooke, U. S. N.;* by Prof. BAILEY.

[The following copy of a letter from Prof. Bailey to Lieut. Maury, of the National Observatory, Washington, D. C., dated West Point New York, January 29th, 1856, has been sent to us for publication.—EDS.]

I have examined with much pleasure the highly interesting specimens collected by Lieut. Brooke of the U. S. Navy, which you kindly sent me for microscopic analysis, and I will now briefly report to you the results of general interest which I have obtained, leaving the enumeration of the organic contents and the description of the new species for a more detailed account which I hope soon to publish.

The specimens examined by me were as follows:

No. 1. Sea bottom 2700 fathoms, lat. 56° 46′ N, long. 168° 18′ E, brought up by Lieut. Brooke with Brooke's lead.

No. 2. Sea bottom 1700 fathoms, lat. 60° 15′ N, long. 170° 53′ E. brought up as above, July 26th, 1855.

No. 3. Sea bottom 900 fathoms, temperature (deep sea) 32° Saxton, lat. 60° 30′ N, long. 175° E.

A careful study of the above specimens gave the following results.

1st. All the specimens contain some mineral matter, which diminishes in proportion as the depth increases, and which consists of minute angular particles of quartz, hornblende, feldspar and mica.

2d. In the deepest soundings (No. 1. and No. 2.) there is least mineral matter, the organic contents (which are the same in all) predominating, while the reverse is true of No. 3.

3d. All the specimens are *very rich* in the siliceous shells of the Diatomaceæ which are in an admirable state of preservation,—frequently with the valves united and even retaining the remains of the soft parts.

4th. Among the Diatoms, the most conspicuous are the large and beautiful discs of several species of Coscinodiscus. There is also (besides many others) a large number of a new species of Rhizosolenia, a new

Syndendrium, a curious species of Chætoceros with furcate horns, and a beautiful species of Asteromphalus, with from five to thirteen rays, which I propose to call Asteromphalus Brookei, in honor of Lieut. Brooke to whose ingenious device for obtaining deep soundings, and to whose industry and zeal in using it, we are indebted for these and many other treasures of the deep.

5th. The specimens contain a considerable number of the siliceous spicules of sponges, and of the beautiful siliceous shells of the Polycistineæ. Among the latter I have noticed Cornatella clathrata *Ehr.*, a form occurring frequently in the Atlantic soundings. I have also noticed in all the soundings (and shall hereafter describe and figure) several species of Eucyrtidium, Halicalyptra, Perichlamidium, Stylodictya and many others.

6th. I have not been able to detect even a fragment of any of the calcareous shells of the Polythalamia. This is remarkable for the striking contrast it presents to the deep soundings of the Atlantic which are chiefly made up of the calcareous forms. This difference can not be due to temperature as it is well known that Polythalamia are abundant in the Arctic seas.

7th. These deposits of microscopic organisms, in their richness, extent, and the high latitudes at which they occur, resemble those of the Antarctic regions, whose existence has been proved by Ehrenberg; and the occurrence of these northern soundings of Asteromphalus and Chætoceros, is another striking point of resemblance. These genera, however, are not exclusively polar forms, but, as I have recently determined, occur also in the Gulf of Mexico, and along the Gulf Stream.

8th. The perfect condition of the organisms in these soundings, and the fact that some of them retain their soft portions, indicate that they were very recently in a living condition, but it does not follow that they were living when collected at such immense depths. As among them are forms which are known to live along the shores as parasites upon Algæ, &c., it is certain that a portion at least have been carried by oceanic currents, by drift ice, by animals which feed upon them, or by other agents, to their present position. It is hence probable that all were removed from shallower waters in which they once lived. These forms are so minute, and would float so far when buoyed up by gases evolved during decomposition, that there would be nothing surprising in finding them in any part of the ocean, even if they were not transported (as it is certain they sometimes are) by other agents.

9th. In conclusion, it is to be hoped that the example set by Lieut. Brooke will be followed by others, and that in all attempts to obtain deep soundings the effort will be made to bring up a portion of the bottom. The soundings from any part of the ocean are sure to yield something of interest to microscopic analysis, and it is as yet impossible to tell what important results may flow from this study.

The above is only a preliminary notice of the soundings referred to. I shall proceed without delay to describe and figure the highly interesting and novel forms which I have detected, and I hope soon to have them ready for publication.

IV. Miscellaneous Intelligence.

1. *Contributions to Meteorology.—Mean results of Meteorological Observations made at St. Martin, Isle Jesus, Lower Canada,* (nine miles west of Montreal,) *for* 1855, by Charles Smallwood, M.D.—The geographical co-ordinates of the place are 45° 31′ N. Lat., and 73° 36′ W. Long. from Greenwich. Height above the level of the sea, 118 feet.

The readings of the barometer are corrected and reduced to 32° F. The whole of the means are obtained from three daily observations taken at 6 A. M., 2 P. M., and 10 P. M.

The mean height of the *barometer* in January was 29·926 inches, in February 29·400, in March 29·716, in April 29·847, in May 29·637, in June 29·757, in July 29·803, in August 29·862, in September 29·834, in October 29·695, in November 29·838, in December 29·429 inches.

The highest reading for the year was on the 8th of January and indicated 30·721 inches; the lowest reading was at 6 A. M. on the 10th of December, and was 28·689 inches; the yearly mean was 29·730, which was 0·059 more than the yearly mean of last year; the mean of the monthly range for the year was 1·050 inches, which was 0·033 less than the range of 1854.

The *atmospheric wave* of November was marked by its usual fluctuations; the highest crest was on the 9th day and indicated 30·265 inches; there were distinct troughs on the 1st, 7th, 16th, 23d, and 20th days, the lowest trough occurred at 4 A. M. on the 28th day, the barometer then stood at 28·997 inches; there was a very sudden rise of the barometer from midnight of the 23d of November till sunrise of the 24th day, of 0·521 inches, accompanied by a very high wind from the NW, which reached a velocity of 38·10 miles per hour. The thermometer fell 25° 0 for the same period.

Thermometer.—The mean temperature of the air by the *standard thermometer*, was in January 17°·88, in February 11°·23, in March 24°·08, in April 40°·15, in May 56°·85, in June 62°·39, in July 72°·73, in August 64°·94, in September 58°·55, in October 46°·35, in November 31°·58, in December 20°·84. The highest reading of the *maximum thermometer* was on the 2nd of August, and was 97° 0; the lowest reading of the *minimum thermometer* was on the 7th of February, and was −33°·9 (below zero). The mean temperature of the quarterly periods was, Winter 12°·15, Spring 40°·36, Summer 66°·68, Autumn 45°·49. The yearly mean was 42°·29, which was 0°·72 degree higher than the yearly mean of 1854; the mean of the yearly range was 61°·1, which was 1°·15 higher than the mean range of 1854. The greatest monthly range was in February, and was 74°·5, and the least monthly range was in October, and was 45°·6. The greatest intensity of the sun's rays was in July, and indicated 127°·2, the lowest point of terrestrial radiations was in February, and was −34°·4 (below zero).

The mean humidity (saturation being 1·000) was, in January ·897, in February ·857, in March ·815, in April ·808, in May ·743, in June ·809, in July ·757, in August ·773, in September ·803, in October ·849, in November ·884, in December ·872. The yearly mean was ·822, which was ·018 *plus* of last year.

Rain fell on 98 days; it was raining 437 hours and 39 minutes: it was accompanied by thunder and lightning on 14 days. The amount of rain exceeded 1·438 inches the amount which fell in 1854. The amount which fell in January was 1·436 inches, in February none, in March 0·531, in April 4·194, in May 1·756, in June 8·217, in July 2·351, in August 4·366, in September 3·471, in October 8·728, in November 3·923, in December 2·970 inches. Total amount 41·943 inches.

Snow fell on 42 days; it was snowing 312 hours 15 minutes, and amounted to 85·91 inches on the surface, which amount was less by 11·54 inches than the amount of snow which fell in 1854. The monthly fall was as follows: in January 20·10 inches, in February 15·00, in March 15·60, in April 4·34, in October 2·10, in November 8·34, in December 20·43 inches. The first snow of the winter 1855–6, fell on the 24th day of October; the whole amount of snow which fell during the winter 1854–5, was 77·91 inches; the present winter set in on the 22d day of December, ferry boats were crossing the day before on the St. Lawrence at Montreal. The first time the thermometer fell to zero was on the 17th of December: the first frost occurred on the 18th of August, and was also felt on the 23d, 27th, 28th, and 31st of the same month, which was very early, and did considerable damage to the crops; (the first frost of 1854 occurred on the 21st of September). The river Jesus was first crossed with loads on the 15th of December.

The amount of evaporation was measured regularly from the 1st of May to the 31st of October, and was discontinued owing to frosty nights. The amount of evaporation in May was 4·22 inches, in June 2·61, in July 3·19, in August 3·80, in September 3·04, and in October 1·40 inches, amounting to 18·26 inches, which was 3·24 inches less than the amount of last year for the same period.

The most prevalent wind, during the year was the west, the least so, the E-by-N; in the winter quarter the most prevalent wind was the NE by E, the least so, the E; in the spring quarter, the most prevalent wind was the W, and the least so, the NE-by-E; in the summer quarter, the most prevalent wind was the WSW, and the least so the S; in the autumn quarter, the most prevalent wind was the W, and the least so the S-by-W. The greatest velocity of the wind was from 2 to 3 P. M. on the 26th April, and was 49·64 miles per hour; the yearly mean of the *maximum velocity* was equal to 15·33 miles per hour. The yearly mean of the *minimum velocity* was 0·16 miles per hour. The quarterly means of the velocities are as follows: *Winter* mean maximum velocity 18·81 miles per hour, mean minimum velocity 0·00. *Spring* mean maximum velocity 21·20 miles per hour, mean minimum velocity 0·05 miles per hour. *Summer* mean maximum velocity 10·18 miles per hour, mean minimum velocity 0·25 miles per hour. *Autumn* mean maximum velocity 17·69 miles per hour, mean minimum velocity 0·36 miles per hour. November and December were more than usually windy, the total amount of miles traversed by the wind in November was 5794·10 miles, and of December 5952·20 miles.

Wild geese, *Anser canadensis*, were first seen here on the 22d of April, swallows, *Hirundo rufa*, were first seen on the 18th of April. The *Rossignol* (the harbinger of the Canadian spring) was first seen on the 9th of April. Frogs, were first heard on the 23d of April,

shad (*Alosa*) were first caught on the 31st of May, snipe were shot on the 30th of April. *Lampyris corusca*, (fire-flies,) were first seen on the 25th of June. Steamers were crossing between Ogdensburgh and Prescot on the 25th of March.

Crows did not winter here this year, they took their departure about the middle of November. *Snow-birds* were first seen on the 10th of November.

The Aurora Borealis was visible on 37 nights as follows:

January 2nd, 10 P. M. *Lunar Halo*, diam. 44° 4′.—10th. Aurora borealis, arch of moderate brightness, dark segment at the horizon.—13th. Slight shock of an earthquake at 5 40 A. M. Barometer 29·280 inches. —31st. *Lunar Halo* at 7 40, diam. 72°.

February 5th. Three mock suns visible at sunrise.—11th, 10 P. M., faint auroral arch; dark segment at the horizon.—12th, 10 P. M., faint auroral arch, dark segment at the horizon.—21st. Lunar Halo at 7 P. M., diam. 38°. *Zodiacal light* very bright during the month.

March 8th, 10 P. M. Faint auroral light to the horizon.—9th, 9 P. M. Extended auroral arch of moderate brightness, dark segment at the horizon.—12th, 7 10 P. M. Streamers shooting up from the horizon uniting in a small circle or corona at the zenith; at 8 5, three distinct auroral arches stretching from E to W, of moderate brightness; 9 P. M., splendid curtain of auroral light of a yellowish-green color changing to a violet and exhibiting the varied hues of the rainbow; 10 P. M., the appearance vanished leaving a bright arch to the horizon. —18th, 10 P. M. Dark stratus at the horizon, auroral arch behind shooting up brilliant streamers.—19, 10 P. M. Faint auroral light, dark segment at the horizon. *Zodiacal light* bright.

April 9th, 10 P. M. A dark mass of stratus in the north, forming a black curtain, behind which is seen an auroral light of moderate brightness, shooting up beautiful streamers of varied colors.—12th, 10 P. M. Extended arch of auroral light of moderate brightness to the horizon.— 15th, 10 P. M. Very faint auroral light at the horizon.—20th, 9 P. M. Dark segment at the horizon. Auroral arch of moderate brightness, frequent streamers. Corona at 11 A. M., diam. 21°.

May 1st, 10 P. M. Faint auroral light.—6th, 10 P. M. Auroral light of moderate brightness.—9th, 10 P. M. Faint aurora borealis.— 23d, *Lunar Halo* at 10 P. M., diam. 36°.—24th, 10 P. M. Auroral arch of moderate brightness, dark segment at the horizon. The eclipse of the moon was not visible here owing to cloudy weather.

June. No aurora was visible during this month. *Lunar Halo* on the 23d, diam. 41°.—24th, 10 P. M. *Lunar Halo*, diam. 47°.

July 7th, 10 P. M. Faint auroral light, dark segment at the horizon. —9th, 10 P. M. Faint auroral light to the horizon.—16th, 10 P. M. Very faint auroral light at the horizon.—23d, 10 P. M. Lunar Halo, diam. 38°.

August 5th, 10 P. M. Faint auroral light at the horizon.—10th, 10 P. M. Faint auroral light.—17th, 10 P. M. Faint auroral light.—23d, 10 P. M. Auroral arch of moderate brightness, dark segment at the horizon; 11 P. M., two distinct arches of bright auroral light, streamers from both arches intermingling, dark segment at the horizon.

Sept. 11th, 10 P. M. Faint auroral light at the horizon, a dark segment underneath; *Meteor* at 9·40 P. M., on the 11th day passing from

Algenib *Pegasi* to *H. Antinoi*, train like a rocket, noiseless.—13th, 10 P. M. Faint auroral light to the horizon.

October 3*d*, 10 P. M. Auroral light of moderate brightness, surmounting a dark bank of stratus clouds.—10th, 10 P. M. Very faint auroral light.—16th, 10 P. M. Very faint auroral light.—24th, 2 30 A. M. Lunar Halo, diam. 31°.

November 2*nd*. Faint auroral light at the horizon.—5th, 10 P. M. Dark segment at the horizon, surmounted by an arch of auroral light, 2° broad; another dark arch surmounted this arch, which was again surmounted by a bright auroral arch 4° broad; occasional streamers.—19th, 10 P. M. Faint aurora to the horizon.—29th, 6·30 P. M. Dark segment at the horizon, surmounted by an arch of auroral light of moderate brightness, intercepted here and there by whitish clouds or patches of auroral light. At 7 30, faint auroral light to the horizon, dark segment had vanished.—30th, 10 P. M. Dark segment at the horizon 6° high, faint auroral light seen above it.

December 5*th*, 10 P. M. Faint auroral light.—7th, 11 P. M. Bright arch of auroral light very low, horizon bright.—13th, 7 P. M. Faint aurora borealis.—30th, 8 P. M. Dark segment at the horizon surmounted by an auroral arch of moderate brightness. *Zodiacal Light* very bright during the month.

Electrical state of the atmosphere.—The atmosphere has afforded almost daily indications of electricity, varying in kind and intensity. I have been able from some years of careful observations, to draw the following inferences.

1st. The electricity of the atmosphere, in serene or windy weather, not accompanied by rain or snow, gives for the most part indications of a positive or vitreous character.

2nd. That during the storms of summer, accompanied by thunder and lightning, the electricity varies in character; it is not unusual to see the electrometer charged and changing its kind from *negative* to *positive* and vice versa, several times in a minutes. Rain falling, generally *fixes* the *kind* of electricity, which is in that case mostly negative in character.

3d. Storms in winter accompanied by snow, when the crystals are of a perfect form, is *always* accompanied by indications of electricity of a negative character and high intensity, but whenever the crystals are imperfect, or are shapeless masses of ice presenting no crystalline form, then the electrometers indicate electricity of a positive character, and of very feeble intensity.

The most perfect form of snow crystal is hexagonal, varying from 0·10 to 0·12 of an inch in diameter, the various angles are beautifully defined if examined immediately, but if allowed to remain for ever so short a time, the points or angles get rounded, and the crystal loses its primitive form and appearance and it is then difficult to define its shape,—I have never seen the hexagonal crystal and its compounds present, without strong indications of negative electricity.

Ozone.—The observations on the amount of ozone are still continued twice daily. I see no reason to suppose the amount has any connexion with the amount of electricity indicated in the atmosphere.

St. Martin, Isle Jesus, C. E., Jan. 24, 1856.

2. *On Papyrus, Bonapartea, and other plants which can furnish Fibre for Paper Pulp;* by Chevalier De Claussen, (Proc. Brit. Assoc., 1855; Athen., 1457.)—The paper-makers are in want of a material to replace rags in the manufacture of paper, and I have therefore turned my attention to this subject, the result of which I will communicate to the Association. To make this matter more comprehensible I will explain what the paper-makers want. They require a cheap material, with a strong fibre, easily bleached, and of which an unlimited supply may be obtained. I will now enumerate a few of the different substances which I have examined for the purpose of discovering a proper substitute for rags. Rags containing about 50 per cent of vegetable fibre mixed with wool or silk are regarded by the paper-makers as useless to them, and several thousand tons are yearly burned in the manufacture of prussiate of potash. By a simple process which consists in boiling these rags in caustic alkali, the animal fibre is dissolved, and the vegetable fibre is available for the manufacture of white paper pulp. Surat, or Jute, the inner bark of *Corchorus indicus*, produces a paper pulp of inferior quality bleached with difficulty. Agave, *Phormium tenax*, and banana or plantain fibre (Manilla hemp), are not only expensive, but it is nearly impossible to bleach them. The banana leaves contain 40 per cent of fibre. Flax would be suitable to replace rags in paper manufacture, but the high price and scarcity of it, caused partly by the war, and partly by the injudicious way in which it is cultivated, prevents that. Six tons of flax straw are required to produce one ton of flax fibre, and by the present mode of treatment all the woody part is lost. By my process the bulk of the flax straw is lessened by partial cleaning before retting, whereby about 50 to 60 per cent of shoves (a most valuable cattle food) are saved, and the cost of the fibre reduced.

By the foregoing it will be seen that the flax plant only produces from 12 to 15 per cent of paper pulp. All that I have said about flax is applicable to hemp, which produces 25 per cent of paper pulp. Nettles produce 25 per cent of a very beautiful and easily bleached fibre. Palm leaves contain 30 to 40 per cent fibre, but are not easily bleached. The Bromeliaceæ contain 25 to 40 per cent fibre. *Bonapartea juncoidea* contains 35 per cent of the most beautiful vegetable fibre known; it could be used not only for paper pulp, but for all kinds of manufactures in which flax, cotton, silk, or wool are employed. It appears that this plant exists in large quantities in Australia, and it is most desirable that some of our large manufacturers should import a quantity of it. The plant wants no other preparation than cutting, drying, and compressing like hay. The bleaching and finishing may be done here. Ferns give 20 to 25 per cent fibre, not easily bleached. Equisetum from 15 to 20 per cent inferior fibre, easily bleached. The inner bark of the lime-tree (Tilia) gives a fibre easily bleached, but not very strong. Althea and many Malvaceæ produce from 15 to 20 per cent paper pulp. Stalks of beans, peas, hops, buckwheat, potatoes, heather, broom, and many other plants contain from 10 to 20 per cent of fibre,—but their extraction and bleaching present difficulties which will probably prevent their use. The straws of the Cereales cannot be converted into white paper pulp after they have ripened the grain,

the joints or knots in the stalks are then so hardened that they will resist all bleaching agents. To produce paper pulp from them they must be cut green before the grain appears, and this would probably not be advantageous. Many grasses contain from 30 to 50 per cent of fibre, not very strong, but easily bleached. Of indigenous grasses the Rye grass contains 35 per cent of paper pulp; the Phalaris 30 per cent, Arrhenatherum 30 per cent, Dactylis 30 per cent, and Carex 30 per cent. Several reeds and canes contain from 30 to 50 per cent of fibre, easily bleached. The stalk of the sugar-cane gives 40 per cent of white paper pulp. The wood of the Coniferæ gives a fibre suitable for paper pulp. I made this discovery accidentally in 1851, when I was making flax cotton in my model establishment at Stepney, near London. I remarked that the pine wood vats in which I bleached were rapidly decomposed on the surface into a kind of paper pulp; I collected some of it, and exhibited it in the Great Exhibition,—but as at that time there was no want of paper material no attention was paid to it. The leaves and top branches of Scotch fir produce 25 per cent of paper pulp. The shavings and sawdust of wood from Scotch fir give 40 per cent pulp. The cost of reducing to pulp and bleaching pine wood will be about three times that of bleaching rags.

As none of the above-named substances or plants would entirely satisfy on all points the wants of the paper-makers, I continued my researches, and at last remembered the papyrus (the plant of which the ancients made their paper), which I examined, and found to contain about 40 per cent of strong fibre, excellent for paper, and very easily bleached. The only point which was not entire satisfactory was relative to the abundant supply of it, as this plant is only found in Egypt. I directed, therefore, my attention to plants growing in this country; and I found to my great satisfaction that the common rushes (*Juncus effusus* and others) contain 40 per cent of fibre, quite equal, if not superior, to the papyrus fibre, and a perfect substitute for rags in the manufacture of paper, and that one ton of rushes contains more fibre than two tons of flax straw.

3. *On the Hancornia speciosa, Artificial Gutta Percha and India Rubber;* by the Chevalier De Claussen, (Proc. Brit. Assoc., 1855; Athen., 1457.)—In the course of my travels as botanist in South America, I had occasion to examine the different trees which produce the india rubber, and of which the *Hancornia speciosa* is one. It grows on the high plateaux of South America, between the tenth and twentieth degrees of latitude south, at a height from three to five thousand feet above the level of the sea. It is of the family of the Sapotaceæ, the same to which belongs the tree which produces gutta percha. It bears a fruit, in form not unlike a bergamot pear, and full of a milky juice, which is liquid india rubber. To be eatable, this fruit must be kept two or three weeks after being gathered, in which time all the india rubber disappears or is converted into sugar, and it is then in taste one of the most delicious fruits known, and is regarded by the Brazilians (who call it Mangava) as superior to all other fruits of their country. The change of india rubber into sugar led me to suppose that gutta percha, india rubber, and similar compounds contained starch. I have therefore tried to mix it with resinous or oily substances, in combina-

tion with tannin, and have succeeded in making compounds which can be mixed in all proportions with gutta percha or india rubber without altering their characters. By the foregoing it will be understood that a great number of compounds of the gutta percha and india rubber class may be formed by mixing starch, gluten, or flour with tannin and resinous or oily substances. By mixing some of these compounds with gutta percha or india rubber, I can so increase its hardness that it will be like horn, and may be used as shields to protect the soldiers from the effect of the Minie balls, and I have also no doubt that some of these compounds in combination with iron, may be useful in floating batteries and many other purposes, such as the covering the electric telegraph wires, imitation of wood, ship building, &c.

4. *On the Artificial Propagation of Salmon at Stormont, near Perth;* by Mr. EDMUND ASHWORTH, (Proc. Brit. Assoc., 1855; Ath., 1457.)—After giving an account of previous experiments on this subject, the author proceeded: On the 19th of July, 1853, a meeting of the proprietors on the Tay was held at Perth, for the purpose of considering a letter on the artificial propagation of the salmon, written by Dr. Esdaile. On that occasion, Mr. Thomas Ashworth, of Poynton, explained to the meeting the nature of the operations which had been carried on at Outerard by his brother and himself, and strongly recommended the adoption of similar measures in the Tay, under the direction of Mr. Ramsbottom. The proposals of Mr. Ashworth were agreed to, and a committee appointed to fix upon a suitable locality for planting boxes and the construction of ponds. The Earl of Mansfield, who was chairman of the meeting, and who has shown much interest in the success of these experiments, gave permission to the committee to make a selection of any portion of his extensive estates on which to carry out their operations. The situation selected was at Stormontfield Mill, near his Lordship's residence. A gentle slope from the stream which supplies the mill offered every facility for the equable flow of water through the boxes and pond. Three hundred boxes were laid down in twenty-five parallel rows, each box partly filled with clean gravel and pebbles, and protected at both ends with zinc grating to exclude trout and insects. Filtering beds were formed at the head and foot of the rows, and a pond for the reception of the fry was constructed immediately below the hatching ground.

On the 23d of November, 1853, operations were commenced, and by the 23d of December 300,000 ova were deposited in the boxes. The fish were taken from spawning beds in the Tay. The process of fecundation will best be understood by a quotation from Mr. Ramsbottom's pamphlet, in which he describes the means employed in impregnating the ova at Outerard. So soon as a pair of suitable fish were captured, the ova of the female were immediately discharged into a tub one-fourth full of water, by a gentle pressure of the hand from the thorax downwards. The melt of the male was ejected in a similar manner, and the contents of the tub stirred with the hand. After the lapse of a minute, the water was poured off, with the exception of sufficient to keep the ova submerged, and fresh water supplied in its place. This also was poured off and fresh substituted previous to removing the impregnated spawn. The ova were placed in boxes as nearly as

possible to the condition they would be in under the ordinary course of natural deposition, with this important advantage: that they are not, as in the bed of the river, liable to injury and destruction. The alluvial matter deposited in time of flood will often bury the ova too deep to admit of the extrication of the young fry, even if hatched; and the impetuosity of the streams when flooded will frequently sweep away whole spawning beds and their contents: whilst, if deposited in boxes, the ova are protected from injury, and their vivification in large numbers is thus rendered a matter of certainty, and the young fish are reared in safety.

On the 31st of March, 1854, the first ovum was observed to be hatched, and in April and May the greater portion had come out, and were at large in the boxes; in June they were admitted into the pond, their average size being about an inch and a half in length. From the period of their admission to the pond the fry were fed daily with boiled liver, rubbed small by the hand. Notwithstanding the severity of the winter, they continued in a healthy condition, and in the spring of the present year were found to have increased in size to the average of three and four inches in length. On the 2nd of May, 1855, a meeting of the committee was held at the pond, to consider the expediency of detaining the fry for another year or allowing them to depart. A comparison with the undoubted smelts of the river then descending seawards with the fry in the ponds, led to the conclusion that the latter were not yet smelts, and ought to be detained. Seventeen days afterwards, viz., on the 19th of May, a second meeting was held, in consequence of great numbers of the fry having in the interim assumed the migratory dress. On inspection it was found that a considerable portion were actual smelts, and the committee came to the determination to allow them to depart. Accordingly the sluice communicating with the Tay was opened, and every facility for egress afforded. Contrary to expectation, none of the fry manifested any inclination to leave the pond until the 24th of May, when the larger and more mature of the smelts, after having held themselves detached from the others for several days, went off in a body. A series of similar emigrations took place until fully one-half the fry had left the pond, and descended the sluice to the Tay.

It has long been a subject of controversy whether the fry of the salmon assume the migratory dress in the second or third year of their existence. So favorable an opportunity of deciding the question as that afforded by the Stormontfield experiment, was not to be overlooked. In order to test the matter in the fairest possible way, it was resolved to mark a portion of the smelts in such a manner that they might easily be detected when returning as grilse. A temporary tank, into which the fish must necessarily descend, was constructed at the junction of the sluice with the Tay; and as the shoals successively left the pond, about one in every hundred was marked by the abscission of the second dorsal fin. A greater number were marked on the 29th of May than on any other day, in all about 1,200 or 1,300. The result has proved highly satisfactory. Within two months of the date of their liberation, namely, May 29 and July 31, twenty-two of the young fish so marked when in the state of smelts on their way to the sea,

have been, in their returning migration up the river, recaptured and carefully examined; the conclusions arrived at are most gratifying, and prove what has heretofore appeared almost incredible, namely, the rapid growth of the young fish during their short sojourn in the salt water. This fact may be considered as still further established by observing the increased weight according to the date of the grilse caught and examined; those taken first weighing 5 to 5½ lb., then increasing progressively to 7 and 8 lb.; whilst the one captured on 31st of July weighed no less than 9½ lb. In all these fish the wound caused by marking was covered with skin, and in some a coating of scales had formed over the part. Although twenty-two only are mentioned, the taking of which rests on indubitable evidence, nearly as many more are reported from distant parts; the weights and sizes of these have not been forwarded.

The experiment at Stormontfield has afforded satisfactory proof that a portion at least of the fry of the salmon assume the migratory dress and descend to the sea shortly after the close of the first year of their existence; and what is far more important in a practical point of view, it has also demonstrated the practicability of rearing salmon of marketable value within twenty months from the deposition of the ova. A very interesting question still remains to be solved:—At what date will the fry now in the pond become smelts? Hitherto, they have manifested no disposition to migrate; and if the silvery coat of the smelt be not assumed till the spring of 1856, a curious anomaly will present itself. Some of the fry as smelts will, for the first time, be descending seawards, of the average weight of two ounces; some as grilse will be taking their second departure to the sea; and others still more advanced will even have completed their second migration, and return to the river as salmon 10 or 12 lb. in weight. It is much to be desired that the experiment at Stormontfield could be continued for a year or two longer, till the links in the chain of evidence now wanting to complete the natural history of the salmon should be obtained.

Sir W. Jardine expressed the obligation of naturalists, sportsmen, and epicures to the originators of these experiments. He thought, however, it was most desirable to fix the nomenclature of the young salmon, to abandon the local name of parrs, smelts, smolts, &c., and to adopt one name that should be recognized by naturalists and experimenters all over the country. There seemed now no doubt of the irregularity of the growth of the salmon in its earlier stages. He had himself caught grilses not more than 5 or 6 oz. in weight, but which were perfectly distinguishable from smolts; and in 1832, a very dry year, when no flood occurred in the Tweed to take down the later shoals of smolts, Mr. Selby, of Twizel, had caught grilse of 11 lb. in weight, which he (Sir William) considered to be the fry of that year which had never left the river. But he regarded the irregularity in the growth and in the time of departure of the young salmon as a natural fact, and not merely a circumstance of artificial breeding.

Sir Philip Egerton stated that not only did the smolts or parr go down the river and come up as grilse of 4 or 5 lb. weight; but he had seen marked grilse come up the river as salmon, weighing 12 lb. He did not think, however, that salmon when they went down came back any larger.

Mr. Ashworth said he had known salmon go down weighing 10 lb. and come up weighing 20 lb.

Sir Philip Egerton, in reply to an observation made by Dr. Lankester, stated that the subject of legislating for the artificial production of salmon had been very often considered by the Legislature, but the difficulty lay in securing property in the fish produced. The proper place to breed salmon was at the heads of rivers; but as the salmon came up from the sea they would be caught by proprietors lower down, and no benefit accrue to the individuals who bred them. There was no doubt the quantity of salmon might be enormously increased by the process recommended.

5. *On certain Curious Motions observable on the Surfaces of Wine and other Alcoholic Liquors;* by Mr. J. Thompson, (Proc. Brit. Assoc., 1855, Ath., 1457.)—The phenomena of capillary attraction in liquids are accounted for according to the generally received theory of Dr. Young, by the existence of forces equivalent to a tension of the surface of the liquid, uniform in all directions, and independent of the form of the surface. The tensile force is not the same in different liquids. Thus it is found to be much less in alcohol than in water. This fact affords an explanation of several very curious motions observable, under various circumstances, at the surfaces of alcoholic liquors. One part of these phenomena is that, if in the middle of the surface of a glass of water, a small quantity of alcohol, or strong spirituous liquor, be gently introduced, a rapid rushing of the surface is found to occur outwards from the place where the spirit is introduced. It is made more apparent if fine powder be dusted on the surface of the water. Another part of the phenomena is, that if the sides of the vessel be wet with water above the general level surface of the water, and if the spirit be introduced in sufficient quantity in the middle of the vessel, or if it be introduced near the side, the fluid is even seen to ascend the inside of the glass until it accumulates in some places to such an extent that its weight preponderates, and it falls down again. The manner in which Mr. Thompson explains these two parts of the phenomena is, that the more watery portions of the entire surface, having more tension than those which are more alcoholic, drag the latter briskly away, sometimes even so as to form a horizontal ring of liquid high up round the interior of the vessel, and thicker than that by which the interior of the vessel was wet. Then the tendency is for the various parts of this ring or line to run together to those parts which happen to be most watery, and so that there is no stable equilibrium, for the parts to which the various portions of the liquid aggregate themselves soon become too heavy to be sustained, and so they fall down. The same mode of explanation, when carried a step further, shows the reason of the curious motions commonly observed on the film of wine adhering to the inside of a wine glass when the glass, having been partially filled with wine, has been shaken so as to wet the inside above the general level of the surface of the liquid; for, to explain these motions, it is only necessary further to bring under consideration that the thin film adhering to the inside of the glass must very quickly become more watery than the rest, on account of the evaporation of the alcohol contained in it being more rapid than the evaporation of the water. On this matter, Mr.

Thompson exhibited to the Section a very decisive experiment. He showed that in a vial partly filled with wine, no motion, of the kind described, occurs as long as the vial is kept corked. On his removing the cork, however, and withdrawing, by a tube, the air saturated with vapor of wine, so that it was replaced by fresh air capable of producing evaporation, a liquid film was instantly seen as a horizontal ring creeping up the interior of the vial, with thick-looking pendant streams descending from it like a fringe from a curtain. He gave another striking illustration by pouring water on a flat silver tray, previously carefully cleaned from any film which could hinder the water from thoroughly wetting the surface. The water was about one-tenth of an inch deep. Then, on a little alcohol being laid down in the middle of the tray, the water immediately rushed away from the middle, leaving a deep hollow there, which laid the tray bare of all liquid, except an exceedingly thin film. These and other experiments, which he made with fine lycopodium powder dusted on the surface of the water, into the middle of which he introduced alcohol gently from a fine tube, were very simple, and can easily be repeated. Certain curious return currents which he showed by means of the powder on the surface, he stated he had not yet been able fully to explain. He referred to very interesting phenomena previously observed by Mr. Varley, and described in the fiftieth volume of the Transactions of the Society of Arts, which he believed would prove to be explicable according to the principles he had now suggested.

6. *On the Absorption of Matter by the Surfaces of Bodies;* by Sir D. Brewster, (Proc. British Assoc., from Athenæum, 1458.)—If we smear very slightly with soap the surface of a piece of glass, whether artificially polished or fused, and then clean it perfectly with a piece of chamois leather, the surface, when breathed upon, will exhibit in the most beautiful manner, all the colors of thin plates. If we breathe through a tube, the colors will be arranged in rings, the outermost of which is black, corresponding to the centre of the system of rings formed between a convex and a plane surface. In repeating this experiment on the surfaces of other bodies, Sir David found that there were several on whose surfaces no colors were produced. Quartz exhibited the colors like glass, but calcareous spar and several other minerals did not. In explaining this phenomenon, the author stated that the particles of the soap, which are dissolved by the breath, must either enter the pores of the bodies or form a strongly adhering film on their surface. This property of appropriating temporarily the particles of soap, becomes a new distinctive character of mineral and other bodies.

7. *On the Existence of Acari in Mica, etc.;* by Sir D. Brewster, (Proc. Brit. Assoc., Ath., 1458.)—While examining with a microscope a thick plate of mica from Siberia, about five inches long and three inches wide, he was surprised to observe the remains of minute animals, some the 70th of an inch, and others only the 150th of an inch in size. Some of these were inclosed in cavities, round which the films of mica were in optical contact. These acari were, of course, not fossil, but must have insinuated themselves through openings between the plates of mica, which afterwards closed over them.—Sir David also read a notice on the Remains of Plants in Calcareous Spar, from King's county,

Ireland, and an account of the analysis of the mineral made for him by Prof. Andrews, of Belfast. The same notice contained an account of specimens of calcareous spar from India, in which copper and iron pyrites were disseminated through them in minute crystals and arranged in strata with clear spaces interposed, parallel to the faces of the primitive rhombohedron.

8. *On the Phenomena of Decomposed Glass;* by Sir D. Brewster, (Proc. Brit. Assoc., 1855, Ath., 1458.)—A notice on the phenomena of decomposed glass, as exhibited in specimens from Nineveh, given to him by Mr. Layard, and in others found among the ruins of St. Leonard's College, St. Andrews. He gave a brief explanation of the manner in which the decomposition took place round different centres, and by which the brilliantly colored films were formed. In the St. Andrews specimen the silex had been restored to its crystalline state in minute prisms, while the manganese took a separate place in opaque crystals.

9. *Floral Calendar, for part of* 1855, *in Lauderdale Co., Ala.;* by Thos. P. Hatch, Prof. of Nat. Science in La Grange Coll., Florence, Ala.—The early spring was at least two weeks later than usual. Later, the progress of vegetation was so rapid as to bring it up with ordinary seasons.—In the following, *lvs.* is a contraction for leaves, *fr.* for fruit, (ripe.) When neither of these follow their specific name, inflorescence is understood. The plants are classified in accordance with Torrey & Gray's N. A. Flora.

March, 1st to 6th; Sambucus Canadensis, lvs.—5th to 10th; Hepatica triloba; Claytonia Virginica; Acer rubrum; Prunus Americanus; Saxifraga Virginica; Hedyotis cerulea; Syringa vulgaris, lvs.; Alnus serulata.—10th to 15th; Myosurus minimus; Isopyrum biternatum; Thalictrum anemonoides; Arabis lævigata; Cardamine rotundifolium; C. hirsuta; Dentaria diphylla, D. laciniata; Draba brachycarpa; Capsella bursa-pastoris; Sagina decumbeus; Cerastium nutans; Oxalis violacea; Aesculus pavia, lvs.; A. glabra, lvs.; Rubus villosus, lvs.; R. trientalis, lvs.; Senecio aureus; Mertensia Virginica; Phlox glutinosa; Benzoin odoriferum; Ulmus racemosa, U. fulva; Pachysandra procumbens; Quercus castanea, lvs.; Sisyrinchium anceps.—15th to 20th; Anemone Caroliniana; Aquilegia Canadensis; Cerastium vulgare; Negundo aceroides; Cerasus serotina; Rosa rubiginosa, lvs.; Symphoricarpus vulgaris; Antenaria plantaginifolia; Phacelia bipinnatifida; Ellisea microcalyx; Phlox divaricata; Sassafras officinale.—20th to 25th; Leavenworthia aurea; Viola palmata, V. pedata; Acer dasycarpum; Vaccinium arboreum, lvs.—25th to 31st; Ranunculus repens, R. abortivus; Liriodendron tulipifera, lvs.; Uvaria triloba; Podophyllum peltatum; Viola sagittata, V. cucullaria; Arenaria patula; Silene virginica; Oxalis stricta; Vicia Caroliniana, V. tetrasperma; Potentilla Canadensis; Cornus florida; Viburnum prunifolium, lvs.; Erigeron bellidifolium; Pedicularis canadensis; Lithospermum latifolium; Phlox pilosa, P. reptans; Syringa vulgaris; Celtis occidentalis; Quercus nigra; Carpinus americana; Ostrya virginica, lvs.; Liquidamber styraciflora, lvs.—Between the 1st and 15th, Cercis canadensis; Amelanchier canadensis.—Between 15th and 31st, Ranunculus Carolinianus; Vaccinium corymbosum.

April 1st to 5th, Thalictrum dioicum; Sanguinaria Canadensis; Claytonia Caroliniana; Tilia heterophylla, lvs.; Acer saccharinum, A. dasycarpum, lvs.; Negundo Aceroides, lvs.; Crataegus punctata; Veronica arvensis, V. peregrina; Quercus nigra; Carpinus americana, lvs.; Erythronium americanum.—5th to 10th, Clematis viorna; Oxalis corniculata; Rhus toxicodendron, lvs.; Acer nigrum; Aesculus pavia; A. glabra; Robinia pseudacacia; Rubus occidentalis; Hydrangea quercifolia, lvs.; Cornus florida, lvs.; Krigia Virginica; Taraxacum dens-leonis; Verbena nubletia; Benzoin odoriferum, lvs.; Carya alba; Pinus inops; Allium striatum; Uvularia flava.—10th to 15th, Actea alba; Corydalis aurea; Stellaria pubescens; Silene antirrhine; Acer saccharinum, lvs., A. nigrum, lvs.; Trifolium repens, T. pratense, T. procumbens; Gleditschia triacanthos; Rubus villosus; Sedum ternatum; Azalea nudiflora; Halesia tetraptera, lvs.; Dodecatheon media; Veronica serpyllifolia; Callicarpa americana, lvs.; Lithospermum canescens; Cynoglossum officinale; Nyssa nudiflora, lvs.; Carya tomentosa; Quercus alba; Q. obtusiloba, Q. falcata, Q. tinctoria, Q. rubra, Q. montana; Platanus occidentalis, lvs.; Morus alba, lvs. and fls.; Hypoxis erecta; Trillium sessile; Uvularia perfoliata.—Between 1st and 15th, Vaccinium stamineum; V. frondosum; Conopholis Americana; Plantago Virginica; P. pusilla.—15th–20th, Sagina decumbens, fr.; Geranium Carolinianum; G. maculatum; Staphylea trifolia; Fragaria virginica; Osmorhiza longistylis; Lonicera sempervirens; Viburnum prunifolium; Krigia virginica, fr.; Cynthia dandelion, C. virginica; Teconia crucigera; Salvia lyrata; Myosotis nana, M. stricta; Phlox maculata; Nyssa nudiflora; Iris cristata.—20th–25th, Ranunculus pusillus; Delphinium tricorne; Liriodendron tulipifera; Viola pubescens; Stellaria aquatica; Rhus toxicodendron; Rubus trientalis; Cratægus crus-galli; Hedyotis purpurea; Coreopsis auriculata; Senecio lobatus; Sonchus asper; Halesia tetraptera; Gratiola sphaerocarpa; Calistegia sepium; Chionanthus virginica, lvs.; Asarum canadense; Castanea vesca, lvs.; Salix nigra; Urtica dioica; Arum triphyllum; Smilax quadrangularis; Medeola virginica; Polygonatum multiflorum.—25th–30th, Ranunculus recurvatus; R. parvulus; Sanguinaria canadensis, fr.; Sisymbium canescens; Lepidium virginicum; Wisteria frutescens; Psoralea melilotoides, P. eglandulosa; Trifolium reflexum; Baptisea leucantha, B. leucophia; Calycanthus floridus: Heuchera Americana; Maruta cotula; Apogon humilis; Specularia perfoliata; Styrax grandifolium; Gratiola floridana; Verbena angustata; V. bracteosa; Monarda Bradburiana; Scutellaria parvula; Lamium amplexicaule; Ellisea microcalyx, fr.; Physalis viscosa; Amsonia tabernæ-montanum; Chionanthus virginica; Euphorbia corollata; Smilacina stellata; Chamaelirium luteum; Tradescantia virginica; Secale cereale.—Between 15th and 30th, Kalmia-latifolia; Scylla esculenta.

May 1st–5th, Fragraria virginica, fr.; Rosa lucida; Hydrangea quercifolia; Bellis integrifolia; Apogon humilis, fr.; Sonchus asper, fr.; Prunella vulgaris; Euphorbia peplus.—5th–10th, Menispermum canadense; Sisymbrium canescens, fr.; Amorpha fruticosa; Oenothera sinuata, O. linearis; Sedum pulchellum; Itea Virginica; Philadelphus grandiflorus; Gallium aparine; Spigelia Marilandica; Circium

altissimum; C. Virginianum; Sagittaria simplex; Allium canadense.—10th–15th, Viola primulæfolia; Tephrosia Virginica; Heliopsis lævis; Vaccinium arboreum; Blephilia ciliata; Marrubium vulgare; Onosmodium Carolinianum; Smilacina racemosa.—Between the 1st and 15th, Clematis cylindrica; Delphinium consolidum; Euonymus Americana; Vitis cordifolia; Gillenia stipulacea; Diospyros Virginiana; Sanicula Marilandica; Erigeron annuum; Gnaphalium purpureum; Plantago lanceolata; Verbascum blattaria; Leonurus cardiaca; Samolus floribundus; Pentstemon pubescens, P. digitalis; Solanum Carolinense, S. nigrum; Rumex acetellosa.—15th–20th, Polygala ambigua; Rosa setigera; Gallium circæzans; Coreopsis senifolia; Leucanthemum vulgare; Frasera Carolinensis.—20th–25th, Magnolia Fraseri; Polygala incarnata; P. purpurea; P. Boyrinii; Ceanothus Americanus; Rubus trientalis; Dianthera Americana; Monarda festulosa; Castanea vesca; C. pumila.—25th–30th, Tephrosia spicata; Trifolium arvense; Schrankia angustata; Decumaria barbara; Gallium trifidum; Cacalia reniformis; Salvia urticifolia.—Between the 15th and 30th, Opuntia vulgaris; Ascyrum crux-andreæ; Hypericum rosmarifolium; Linum virginicum; Lespedeza repens; Cryptotænia canadensis; Erigeron strigosum; Silphium scaberrimum; Lepachys pinnata; Dipteracanthus hybridus; Leonurus carsiaca; Teucrium canadense; Scutellaria integrifolia, S. pilosa; Datura stramonium; Asclepias variegata, A. obtusifolia, A. tuberosa; Anantherix viridis; Polygonum hydropiper; Phyllanthus Carolinensis; Aristolochia serpentaria.

June 1st–5th, Passiflora incarnata; Hydrangea radiata.—5th–10th, Anemone Virginana; Astragalus, n. sp.; Sambucus Canadensis; Actinomeris helianthoides; Phlox acuminata.—10th–15th, Cornus sericeus; Sericocarpus solidagineus; Achillea millifolium; Euphorbia maculata.—Between the 1st and 15th, Hypericum corymbosum, H. angulosum; Stylosanthes elatior; Sambucus pubescens; Leptopoda brachypoda; Lobelia glandulosa; Gerardia flava; Nepeta cataria; Calamintha nepeta; Hypopitis lanuginosa; Polygonum aviculare; Lilium Carolinianum.—15th–20th, Eupatorium rotundifolium.—20th–25th, Callicarpa Americana; Martynia proboscidia.—25th–31st, Portulacca oleracea; Diervilla trifida; Andromeda arborea; Verbena spuria.—Between the 15th and 31st, Cleone pungens; Impatiens pallida, I. fulva; Petalostemon violaceum, P. canadense; Rhyncosia tomentosa; Crotalaria sagittalis, C. ovalis; Rhexia mariana; Cephalanthus occidentalis; Pycnanthemum linifolium; Lobelia inflata; Tecoma radicans; Sabbattia angularis; S. calycosa; Phytolacca decandra; Polygonum Pennsylvanicum; Cypripedium pubescens.

July 1st–5th, Conoclinum cœlestinum; Hedeoma pulegeoides.—5th–10th, Agrimonia eupatoria; Cuphea viscosissima; Scrophularia nodosa.—10th–15th, Nelumbium nucifera; Desmodium nudiflorum; Circium lanceolatum; Euphorbia hypericifolia.—Between the 1st and 15th, Lathyrus palustris; Vernonia fasciculata; Pycnanthemum incanum; Commelina erecta.

Ferns.—Pteris atropurpurea; Adiantum pedatum; Camptosaurus rhizophyllus; Aspleneum ebeneum, A. pinnatifidum; Polystichum acrostichoides; Osmunda cinnamomea; Botrychium virginicum; Ophioglossum vulgare.

10. *Death of Dr. T. W. Harris.*—Died at Cambridge, Mass., on the 16th January, 1856, THADDEUS WILLIAM HARRIS, M.D., widely known as an eminent entomologist. He was the son of Rev. Thaddeus Mason Harris, D.D. of Dorchester, Mass., and was born in that town, Nov. 12, 1795. He was graduated at Harvard College in 1815, and after going through a regular course of medical study, he established himself in the practice of the profession in the town of Milton. Early imbued with an ardent love of nature, he relieved the laborious duties of his profession by the study of natural science. In 1831, on the death of Mr. Benjamin Peirce, he was appointed the Librarian of Harvard College, and he filled the office with credit and usefulness to the close of his life.

While faithfully discharging the duties of this station he found time for the pursuits of natural history, directing his attention chiefly to the important, but much neglected, field of Entomology. In this department of science he rose to distinction, and since the death of Say, he has unquestionably stood at the head of American entomologists. His earlier contributions in relation to insects appeared in the New England Farmer of Boston, and in other agricultural journals, and like his later papers were marked by accuracy and thoroughness. In October, 1832, he delivered the anniversary discourse before the Massachusetts Horticultural Society, (Camb. 1832, pp. 54 and 42, 8vo), in which he set forth in an interesting manner "the relations subsisting between insects and plants, and the useful results to be obtained by the cultivator from a knowledge of the habits and economy of insects." In 1833, in the Fourth Part of Prof. Hitchcock's Report on the Geology, &c. of Massachusetts, was published Dr. Harris's Systematic Catalogue of the insects of that State. This list, comprising 2350 species, nearly all contained in his own cabinet, although as he freely admitted, quite imperfect, is noticeable as the first printed general catalogue of the insects of any part of our country;—that of Melsheimer, published in 1806, being confined to the Coleoptera.

In 1837, he was requested to prepare a report on the insects of Massachusetts, to be included among the Reports of the Commissioners on the Zoological and Botanical Survey of the State. In so vast a range as lay before him, he wisely determined to limit himself to such a treatment of his subject as would best promote the agricultural interests of the Commonwealth. No person in this country was better qualified to undertake the task, and no one but Dr. Harris could have accomplished it so satisfactorily. His report was published by the State in 1841. A small impression of the work, with slight alterations, was issued at Cambridge in 1842 under the title of "*A Treatise on some of the Insects of New England which are injurious to Vegetation*," (Cambr. pp. 459, 8vo.) A second edition of the book, revised and enlarged, was published in 1852, (Bost. pp. viii, and 513.)

This admirable treatise was received with great favor both by the cultivators of the soil, and by the cultivators of entomological science. In a style simple, clear, and exact, Dr. Harris gives, after a general view of his subject, a systematic account of such of our insects as are specially important on account of their injuries to plants or fruits, describing with much fullness their forms and their habits, and pointing out the best methods of preventing or remedying their attacks. The

work is a treasure of valuable information, and will be an enduring monument of the industry and learning of its author.

Dr. Harris was of modest and retiring habits, and so cautious to avoid error, so anxious for the whole truth, that his published writings fail to do justice to the full extent of his abilities. "Yet," to use the language of one who knew him well, "he had abundantly the self-respect which belongs to unselfish labors to advance the world in the knowledge of the works of its Maker, and to the uniform tenor of a pure, useful, Christian life."

11. *Rev. Zadock Thompson*, Professor of Natural History in the University of Vermont, died at Burlington, January 19, 1856, aged 59. Mr. Thompson early interested himself in the study of the history and physical features of the state of Vermont, and in 1824 published a Gazetteer of the State which to a large extent was made from information gathered by his personal labors. In 1842 this work was incorporated in a much larger one of wider range of subjects entitled "History of Vermont, Natural, Civil, and Statistical, in three parts," a thick 8vo volume of 650 pages, one third of it devoted to the Natural History of the State. A supplement to this work, of 64 pages, appeared in 1853, bringing down the subjects of the Natural History and physical geography of Vermont to the date of publication. Among Mr. Thompson's researches, the discovery of the remains of a whale in the vicinity of Lake Champlain as a post-tertiary fossil was of special interest, proving that in the latest of geological periods preceding man, Lake Champlain was a cruising ground for northern Cetaceans. All his investigations were pursued with great zeal, fidelity, and success, and at the same time without ostentation. At the time of his death he was officially engaged in making a survey of the State of Vermont, embracing its Physical Geography, Geology and Mineralogy, Botany and general Zoology.

12. *Theory of the Winds;* by Captain CHARLES WILKES, U. S. N., (Read before the American Association at Providence, Aug. 20, 1855), accompanied by a map of the World, showing the extent and direction of the Winds; to which is added Sailing Directions for a voyage around the world. 116 pp., large 8vo. Philadelphia, 1856.—This volume, as the author states in his Introduction, forms part of his Report on Hydrography, the xviith volume of the Government Edition of the United States Exploring Expedition Reports. Capt. Wilkes speaks of his Report as a "sealed book," like the other Reports of the Expedition, "for there are only one hundred copies ordered by the Government for the use of the world!" He has therefore published a portion of the work for distribution. To give a just exposition of the Theory would require a review of many pages; and we have therefore to refer the reader to the volume itself. Capt. Wilkes combats the common doctrine that the rotation of the earth has any thing to do with the course or velocity of the Trade winds, and also observes that we have no satisfactory evidence of currents in the atmosphere passing from the polar to the equatorial regions. He lays down as the prominent point in his theory, that if there is a change of temperature in the atmosphere, there is a disturbance of equilibrium, the denser and colder portion seeking the warmer from every direction to restore the equilibrium in the most direct lines it can follow: and after remarking on this principle, he

points out the areas of greatest mean heat, and his inferences therefrom. Connected with this subject, he discusses the relations and influence of vapors in the atmosphere, and also of electricity in great storms.

13. *Description of a portion of the lower Jaw and a Tooth of the Mastodon Andium; also of a Tooth and fragment of the Femur of a Mastodon from Chile;* by JEFFRIES WYMAN. 10 pp., 4to, with two plates. From Gilliss's Report on Chili, vol. ii.—Dr. Wyman sustains the view that there are remains of two species of Mastodon in South America, the *M. Andium* and *M. Humboldtii*; and possibly a third from Chili.

14. *A Memoir on the Extinct Sloth Tribe of North America;* by JOSEPH LEIDY, Prof. Anat. Univ. Pennsylvania, etc. 68 pp., 4to, with 16 lithographic plates, (from the Smithsonian Contributions to Knowledge).—Dr. Leidy has here reviewed the facts relating to the extinct Sloth tribe of North America, and added much that is new from specimens under his examination. The species described are Megalonyx Jeffersonii *Harlan*, Megalonyx dissimilis *Leidy*, Ereptodon priscus *Leidy*, Mylodon Harlani *Owen*, Megatherium mirabile *Leidy* (the North American Megatherium, which Dr. Leidy regards as distinct from the M. Cuvieri of South America.) The plates are excellent.

15. *Contributions towards a Knowledge of the Marine Invertebrate Fauna of the Coasts of Rhode Island and New Jersey;* by Prof. J. LEIDY, M.D. 18 pp. 4to, with 2 4to plates. Philadelphia, 1855. (From the Jour. Acad. Sci., Philad., vol. iii, 2nd Series.)—This paper contains enlarged views of the lasso-cells of the Astrangia, first made known and figured by Agassiz, besides descriptions and figures of several new species of worms, Polyps, etc., and one Crustacean, *Cepon distortus*, found in the branchial cavity of the Gelasimus pugilator.

16. *An Essay on Meteorites;* by R. P. GREG, F.G.S. 40 pp. 8vo, Nov., 1855. Manchester.—This important essay was originally issued as an article in the Philosophical Magazine for November and December, 1854, and is now published by the author with additions, in which he considers at some length the lunar theory of meteorites. He gives a catalogue of known meteoric falls, and compares them for different periods and countries. He concludes, that the origin of meteorites "is not within the limits of the atmosphere, and that some of them at least cannot have had a lunar origin;" that they are probably distinct in nature and orbits from ordinary luminous meteors; and that the falls are least frequent when the earth is in perihelion, and most so when it is in aphelion, the mean system or mass of the asteroids being in their perihelion; and finally, that they may be reasonably considered as belonging to the group of planetoids or asteroids, and therefore as of the nature and conditions of asteroids.

17. *Synopsis of the Classification of the British Palæozoic Rocks;* by the Rev. ADAM SEDGWICK, M.A., F.R.S., etc., with a Systematic Description of the British Palæozoic Fossils in the Geological Museum of the University of Cambridge, by FREDERICK McCOY, F.G.S., etc. 4to, pp. xcviii, and 407–622, with many plates, 1855.—This 3d Fasciculus closes the Palæontological volume of Prof. McCOY. The whole is a grand contribution to science under the auspices of Prof. SEDGWICK, and the Geological part is the result of his special labors. We defer to another number a farther notice of the volume.

18. *Vienna Scientific Publications.*—The scientific publications issued annually in Vienna are not exceeded by those of any other city in Europe.

The Academy of Sciences published in 1854, in its Mathematico-Natural History section alone, 2 thick 4to volumes, printed in a style of unusual elegance, containing articles of the highest character in almost every branch under that section, and illustrated by numerous elegant plates; and besides this, the Bulletin of the Academy in 10 parts of 250 to 300 pages each, also finely printed and profusely illustrated. The Kais. Kön. Geologischen Anstalt publishes a quarterly Bulletin of more than 200 pages in small 4to; and in 1852 issued a volume of Transactions in large 4to, with many fine plates of fossils, etc. There is also a large 4to volume issued, entitled "Jahrbücher der K. K. Central-Anstalt für Meteorologie und Erdmagnetismus von KARL KREIL, which is brought out under the auspices of the Academy of Sciences. The volume for 1851 was published in 1855.

Volume ix of the Transactions of the Academy (1855) opens with an extended account (in Latin) of the structure and relations of the *Chlamydophorus truncatus* of Harlan, with many plates of great beauty, illustrating its anatomical structure, by JOSEPH HYRTL. The other papers are as follows:—Beitrag zur Kenntniss der Grundlagen von Piazzi's Sternkatalog, von K. v. LITTROW, 73 pages.—Beit. z. Kenntn. der Cephalopoden Fauna der Hallstätter Schichten, mit 5 Tafeln, von Fr. R. v. HAUER.—Ueber zwei Polyparien aus den Hallstätter Schichten, mit 1 Tafel, von A. E. REUSS.—16 Gattungen von Binnenwürmern und ihrer Arten, mit 6 Tafeln, von Dr. K. M. DIESING.—Schildkrötenreste aus den Oesterreichischen Tertiär-Ablagerungen, mit 6 Tafeln, von K. F. PETERS, (including fine plates of several new species of fossil turtles.)—Ueber die Brachiopoden der Hallstätter Schichten, mit 2 Tafeln, von E. SUESS.—Ueber die Gastropoden und Acephalen der Hallstätter Schichten mit 2 Tafeln, von Dr. M. HORNES.—Brechung und Reflexion des Lichts an zwillingsflächen optisch-einaxiger vollkommen durchsichtiger Medien, von J. GRAILICH.

19. *Journal of the Academy of Natural Sciences of Philadelphia, New Series.* Vol. III, Part II. 1855.

Art. VIII. Notice of Fossils from the Carboniferous Series of the Western States, belonging to the genera Spirifer, Bellerophon, Pleurotomaria, Macrocheilus, Natica, and Loxonema, with descriptions of eight new characteristic species; by J. G. NORWOOD and H. PRATTEN, of the Illinois Geological Survey.

IX. Plantæ Prattenianæ Californicæ: An enumeration of a collection of California Plants, made in the vicinity of Nevada, by Henry Pratten, Esq., of New Harmony; with critical notices and descriptions of such of them as are new, or yet unpublished in America; by ELIAS DURAND.

X. Relation of Atomic Heat to Crystalline Form; by J. A. MEIGS, M.D. (An important exhibition of the relations of bodies as to their atomic heat, crystalline form, atomic volume, etc.)

XI. Contributions towards a knowledge of the Marine Invertebrate Fauna, of the coasts of Rhode Island and New Jersey; by JOSEPH LEIDY, M.D.

XII. Descriptions of New Species of Psittacidæ, in the collection of the Academy of Natural Sciences of Philadelphia; by JOHN CASSIN.

The Culture of the Grape and Wine making, by ROBERT BUCHANAN, with an Appendix containing directions for the cultivation of the Strawberry, by N. LONGWORTH. 6th ed. 142 pp. 12mo. Cincinnati, 1855.

The Unity of Matter: A Dialogue on the relation between the various forms of matter which affect the senses; by Alex. Stephen Wilson. 80 pp. 16mo. 1855, London: J. Highley.

Videnskabelige Meddelelser fra den naturhistoriske Forening i Kjöbenhavn for Aaret 1853. Udgivne af Selskabets Bestyrelse. Copenhagen, 1854.—Opens with observations on the Papilionaceæ, Scrophularineæ, Labiatæ, Malpighiaceæ and Gentianeæ of Central America; by A. GRISEBACH and A. S. OERSTED. 58 pages.—Also contains a paper on Greenland Ornithology by J. REINHARDT; and on new Mexican Plants by F. LIEBMAN; and new species of Castelia by the same.

Handbuch der Metallurgischen Hüttenkunde, zum Gebrauche bei Vorlesungen und zum Selbstudium, bearbeitet von BRUNO KERL, Königl. Hannov. Hüttenmeister und Lehrer der Hüttenkunde und Probirkunst an der Königl. Bergschule zu Clausthal. 3 vols. Freiberg, 1855.

PROCEEDINGS BOSTON SOC. NAT. HIST.—Vol. V, DEC. 1855.—p. 257, Abstract of a memoir on the fossil foot-prints in the Carboniferous strata of Pennsylvania (advocating the view that they were Reptilian); *J. Wyman.*—On the so-called verd-antique marble of Roxbury, Vermont; *A. A. Hayes.* (Analyses show that the white portions are carbonate of magnesia).—p. 265, Note on the bones of the Mastodon found near Shell River, N. America.—p. 266 and 282, On the terminal velocity of raindrops of different diameters; *W. B. Rogers.*—p. 268, Oyster shells found in Charles River.—On the cohesive properties of Gutta Percha pipe of different sizes; *H. R. Storer* and *C. Stodder*, with remarks by other members.—JANUARY, 1856.—p. 274, Notes on the dissections of a Chimpanzee; *J. Wyman.*—p. 275, On the foot-print of a living Ostrich; *J. Wyman.*—Note on the Filaria Medinensis; *S. Durkee.*—p. 278, Parentage of the "Aztec" Children.—p. 279, Copper veins of the Phenix Mine on Eagle River, L. Superior.—p. 283, On the origin of the carbonate of iron of the Coal measures; *W. B. Rogers.*

PROCEEDINGS OF THE ACAD. NAT. SCI. PHILADELPHIA.—Vol. VII, No. XII, 1855.—p. 415, Descriptions of a few species of Coleoptera supposed to be new; *P. R. Uhler.*—p. 420, Catalogue of the Human Crania in the Collections of the Academy; *J. A. Meigs.*—p. 423, Descriptive Catalogue of the Raninæ (species of Rana, etc.) of the United States; *J. LeConte.*—p. 431, Observations on the N. American species of Bats; *J. LeConte.*—p. 438, Notice of some new and little known Birds in the collection of the U. S. Exploring Expedition in the Vincennes and Peacock, and in the collection of the Academy; *J. Cassin.*—p. 441, Note on the Miocene and Post-pliocene deposits of California, with descriptions of two new Fossil Corals and description of a new species of Pentamerus; *T. A. Conrad.*—p. 442, Descriptions of two new species of Hesperomys; *J. LeConte.*—p. 443, Notices of some Tape Worms; *J. Leidy.*—Enumeration of Mosses detected in the Northern U. States, not comprised in the Manual of A. Gray, some of which are new; *T. P. James.*

Works received from G. A. Koch's Verlagsbuchandlung, Th. Kunike:

Natalicia Regis augustissimi Friderici Gulielmi IV., A. D. xv. M. Octobr. Hora xii. in auditorio minore celebranda indicunt Universitatis Regiæ Gryphiswaldensis Rector et Senatus. Inest G. F. Schoemanni Dissertatio de veterum criticorum notis ad Hesiodi Opera et Dies. Gryphis-waldiæ. Typis Frid. Guil. Kunike, Reg. Acad. Typogr., 1855.

Index Scholarum in Univ. Litteraria Gryphiswaldensi per semestre Hibernum, Anni MDCCCLV–VI, a die xvi mensis Octobris habendarum. Inest G. F. Schœmanni Dissertatio de causa Leptinea.—Typis ibid.

Wörterbuch der Niederdeutschen Sprache älterer und neuerer Zeit, verfasst von J. G. L. Kosegarten. Ersten Bandes, erste Lieferung. A—Ai. Greifswald, 1856.

Mythologische Beiträge zu den neuesten wissenchaftlichen Forschungen über die Religionen des Alterthums mit Hülfe der vergleichenden Sprachforschung, von Dr. K. Th. PYL, Docenten für Archaiologie und neure Kunstgeschichte an der Universität, Greifswald.—1 Theil, Das Polytheistische System der Griechischen Religion nebst einer literaturhistorischen Einleitung. 218 pp. 8vo. Greifswald, 1856.